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The Relationship Between Extracurricular STEM Activities and Performance on the Florida Science Assessment

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THE RELATIONSHIP BETWEEN EXTRACURRICULAR STEM ACTIVITIES AND PERFORMANCE ON THE FLORIDA SCIENCE ASSESSMENT

by

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ABSTRACT

Students with disabilities perform below their non-disabled peers in science (National Center for Educational Statistics [NCES], 2011; National Educational Longitudinal Study [NELS], 1998; National Science Foundation [NSF], 2013). The achievement gap is a problem because the nation's competitiveness depends on individuals with science, technology, engineering, and mathematics (STEM) knowledge, skills, and abilities to drive innovation that will lead to new products and economic growth (Business-Higher Education Forum [BHEF]/Act Policy Brief, 2014; National Academies of Sciences, Engineering, and Medicine, 2016; National Science Board, 2015). If Florida is to continue to grow and prosper, all students, including students with disabilities must be prepared for the economy they will inherit. The purpose of the current study was to determine if informal science learning activities offered in Florida school districts impact students with disabilities (SWD) performance on the 8th Grade Florida science assessment.

The researcher posed four research questions. The first research question determined whether a statistically significant difference existed between students with disabilities and their non-disabled peers on the 8th Grade Florida Science Assessment. The researcher found a statistically significant difference of students without disabilities outperforming their peers with disabilities. The second and third research questions were analyzed using survey responses from STEM personnel in each Florida district. The questions evaluated the percentage of SWD who participate in STEM activities. Findings indicated most districts do not track the number of SWD who participate in STEM activities. The third research question determined the type of SWD who participated in STEM activities. The largest category represented in STEM activities was students with learning disabilities. The last research question asked if there was a correlation between the number of STEM activities offered in a district and the results of the 8^{th} Grade Statewide Science Assessment for SWD. Results indicated a small positive correlation. The researcher identified areas for future research, as well as recommendations and implications of the results from the study.

My dissertation is dedicated to my husband and children, Steve, Jacob, Kyle and Scott, who taught me the importance of love, dedication, hard work, and priorities in life. Thank you for your patience and understanding. I love you all.

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LIST OF ACRONYMS

ADHD	Attention deficit hyperactivity disorder
ASD	Autism spectrum disorder
CEC	Council for Exceptional Children
DOE	Department of Education
FIRST	For Inspiration and Recognition of Science and Technology
IDEA	Individuals with Disabilities Education Act
IES	Institute of Education Sciences
IRB	Institutional Review Board
LD	Learning Disability
LRE	Least Restrictive Environment
NCES	National Center for Educational Statistics
NLTS2	National Longitudinal Transition Study – 2
NSF	National Science Foundation

SLD	Specific Learning Disability
SSA	Statewide Science Assessment
STEM	Science, technology, engineering, and math
SWD	Students with disabilities
U.S.	United States

CHAPTER ONE: INTRODUCTION

Students with disabilities (SWD) have historically and consistently struggled in science (National Center for Education Statistics [NCES], 2011; National Educational Longitudinal Study [NELS], 1998; National Science Foundation, 2013). Reasons for the achievement gap in science include a lack of access to the general curriculum and unequal and inadequate educational services (Rice, Merves, & Srsic, 2008). After SWD began to attend public schools, reformers started to focus on the services they were provided. Educators, however, were not ready to meet this population's diverse needs (Brownell, Sindelar, Kiely, & Danielson, 2010). Many SWD were taught in separate classrooms using prescriptive teaching methods (Arter & Jenkins, 1977). Through litigation and legislation many improvements have transpired over the years for SWD. Litigation and legislation included two major historical events which impacted SWD; *Brown vs. Board of Education* (1954) and the Education for All Handicapped Children Act (EAHCA; 1975), now called the Individuals with Disabilities in Education Act (IDEA).

Brown vs. Board of Education (BOE; 1954) opened the doors for all students to be educated on equal terms (Brownell, Sindelar, Kiely, & Danielson, 2010; Rudd, 2002). Parents and advocates used the *Brown v. Board of Education* decision to encourage the inclusion of SWD and students of color while providing equal education opportunities (Diaz, 2013; Nolan, 2004). The exclusion of SWD and lack of educational equality led to government regulations and agencies to protect individuals with disabilities. Despite the impact of *Brown vs. BOE* on SWD, additional legislation was necessary for the equal and adequate education of SWD.

In 1975, the U.S. congress passed the Education for All Handicapped Children Act (EAHCA) (P.L. 94-142). The authors of EAHCA provided federal funding for states to educate all SWD. State education officials were required to submit a plan to the government to receive federal funds. Furthermore, legislators mandated SWD had the right to (a) nondiscriminatory testing, evaluation, and placement; (b) be educated in the least restrictive environment (LRE); (c) parental involvement and due process; and (d) a free and appropriate education (20 U.S.C. § 1400, 2004; Yell, Rogers, & Rogers 1998). The intent of the authors of the EAHCA mandates was to open the doors for SWD to be educated with their non-disabled peers, also known as inclusion.

To frame this strudy, the researcher presents information on SWD, Science, Technology, Engineering, and Mathematics (STEM) activities, and student outcomes on standardized science assessments. Two frameworks are presented to build a foundation for the analysis of the data. The two models, Framework for 21st Century Learning (2009) and Social Constructivism (Vygotsky, 1978) are integrated with the current literature and analyzed to create a hypothesis regarding ways to increase learning and subsequent standardized test scores in science for SWD. Through these frameworks, the researcher established current trends and issues for SWD during STEM activities, science instruction, and assessment. Current statistics and research are presented pertaining to STEM activities and SWD.

Statement of the Problem

A robust and diverse STEM workforce is critical to our nation's competitiveness because individuals with STEM knowledge, skills, and abilities drive the innovation that will lead to new products, industries, and economic growth (BHED/Act Policy Brief, 2014; National Academies of Sciences, Engineering, and Medicine, 2016; National Science Board, 2015). The number of STEM occupations requiring STEM capabilities is growing. For example, Klowden, Keough, and Barrett (2014) reported global competition in technology and science is crucial, considering the increased reliance on innovation. If Florida is to continue to prosper, all students must be prepared to actively contribute to the economy they will inherit.

A clear need exists for more diverse STEM workers. However, only 5% of SWD enter the STEM workforce (Leddy, 2010). In 2011, Newman et al., identified less than 9% of undergraduate university SWD reported majors in engineering and only 6% reported majors in science or computer-related areas. One reason SWD do not enter the STEM workforce is because they struggle in science (Basham & Marino, 2013). This trend becomes increasingly clear in middle school where the decision is often made to pursue advanced science and engineering courses (Hartung, Porfeli, & Vondracek, 2008).

Further exacerbating this issue of disparity in science achievement of SWD is the recent shift to the Next Generation Science Standards and College and Career Readiness Standards. This shift has placed more focus on student acquisition of science content through (a) asking questions and defining problems; (b) developing and using models; (c) planning and carrying out investigations; (d) analyzing and interpreting data; (e) using mathematics and computational thinking; (f) constructing explanations and designing solutions; (g) engaging in argument from evidence; and (h) obtaining, evaluating, and communicating information (Florida Department of Education; FLDOE, 2012). The new standards and curriculum have increased the amount of academic rigor and expectations for all students.

While accommodation and technology help SWD develop stronger procedural skills, apply organizational strategies, and transfer reading and mathematics skills to the science content area, these accommodations do not always enhance scientific reasoning (Marino et al, 2014; Mutch-Jones, Puttick, & Miner, 2012; Stefanich, 2007). The increased demands on the science content can lead to frustration, academic failure, loss of access to the general education curriculum, and loss of future STEM opportunities for SWD (Mastropieri et al., 2006; Marino, 2010).

Informal Science, Technology, Engineering, & Mathematics Learning

There is a need for reform in Science, Technology, Engineering, and Mathematics (STEM) education to attract a more diverse workforce (Denson, Hailey, Stallworth, & Householder, 2015). Watson and Froyd (2007) reported a diverse population in STEM careers increased the level of creativity, innovation, and quality of STEM products and services. However, many STEM learning environments are formal and fail to introduce underrepresented students to STEM professions (Denson, Austin, & Hailey, 2013). Furthermore, researchers have recognized the importance of informal learning environments that will be instrumental to the reform of STEM education (Denson et al., 2015; Martin, 2004).

Chubin, May, and Babco (2005) postulated an effective informal learning environment in STEM must (a) promote awareness of engineering; (b) provide academic enrichment; (c) have trained and competent instructors; and (d) be supported by the educational system of the student participants. Informal learning environments are categorized into (a) every day experiences, (b) designed settings, and (c) programmed settings (Kotys-Schwartz, Besterfield-Sacre, & Schuman, 2011). Informal learning environments typically take place outside of the traditional classroom environment and have been an integral part of education for years (Stocklmayer, Rennie, & Gilbert, 2010). Informal learning environments are often called extracurricular activities.

Extracurricular Activities

In 2001, the Council for Exceptional Children (CEC) reported SWD who participated in after-school programs that offer a variety of experiences developed skills and self-confidence. These social and emotional skills are difficult to achieve in the typical classroom setting (Snellman, Silva, Frederick & Putnam, 2015). Kleinert, Miracle and Sheppard-Jones (2007) pointed out IDEA requires schools to provide access to extracurricular activities and recommended participation in after-school programs be included in students' Individual Education Programs (IEPs). After-school clubs can integrate needed work place (soft) and social skills interventions with students who share similar interests in a natural, informal, learning environment. Students with disabilities develop social competence by experiencing friendships and gaining valuable teamwork skills. These experiences are needed for many post high school jobs, especially in the STEM areas.

Extracurricular activities have been associated with improved academic performance and psychosocial development (Durlak, Weissberg, & Pacan, 2010). Students who participate in after-school activities have been positively linked to higher grades, test scores, school value, school engagement, and educational aspirations (Fredricks & Eccles, 2008). Additionally, participants have positive psychological benefits such as higher self-esteem, psychological resiliency, and lower rates of depression (Fredricks & Eccles, 2008). Moreover, some studies show a link to after-school club participation and lower dropout rates, delinquency, and substance abuse levels (e.g., Eccles & Barber, 1999; Mahoney, 2000; Mahoney & Cairns, 1997). Unfortunately, there is a lack of research on the outcomes of extracurricular participation by SWD.

Extracurricular Activities and the Law

In 2013, the Office for Civil Rights issued guidance on school districts' legal obligation to provide SWD equal access to extracurricular athletic activities. According to Section 504 of the Rehabilitation Act, SWD have an equal opportunity to participate in extracurricular activities. However, in 2010 the U. S. Government Accountability Office (GAO) found many SWD were not given an equal opportunity to participate in extracurricular athletics Galanter (2013).

Specifically, the authors of the GAO report (2010) stated, “Under the implementing regulations for both IDEA and Section 504, schools are required to provide students with disabilities equal opportunity for participation in extracurricular activities, which often include athletics” (p.2). The guidance is often interpreted to include extracurricular activities such as STEM clubs and hobbies (*Independent School District No. 12, Centennial v. Minnesota Department of Education*, 2010).

Purpose and Research Questions

Researchers suggest that participation in out of school science learning experiences has a positive influence on participants’ attitudes about science both short term and longitudinally (Antink-Meyer, Bartos, Lederman, & Lederman, 2014; Bhattacharyya, Mead, & Nathaniel, 2011; Bischoff, Castendyk, Gallagher, Schamloffel, & Labroo, 2008; Fields, 2009; Luehmann, 2009). Furthermore, students who participated in extracurricular activities have better outcomes than students who do not participate (Durlak, Weissberg, & Pachan, 2010). However, SWD are underrepresented in extracurricular activities and struggle with middle school science (Brigman, Webb, & Campbell, 2007; Marino et al., 2014; U. S. Government Accountability Office, 2013). Therefore, additional research is needed to determine the effect on SWD participation in extracurricular activities and learning outcomes in science (Shields, King, Corbett, & Imms, 2014).

The purpose of the current study was to determine if there were differences between students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the types of STEM activities offered in Florida school districts, and the percentage and type of SWD who participate in STEM activities in each district. Furthermore, the researcher examined the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Science Assessment. The findings from this investigation should assist policymakers, administrators, and teachers in understanding the relationship between extracurricular activities and SWD performance in science. Findings should add to the general knowledge and understanding of extracurricular activities and their impact on SWD.

The research design for this study was guided by the following questions:

- RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science assessment?
- RQ2: What percentage of SWD do school personnel report as participating in after-school STEM activities?
- RQ3: What federal category of SWD (e.g., specific learning disability) do school personnel report as having the highest level of participation during after-school STEM activities?
- RQ4: What is the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Statewide Science Assessment?

Theoretical Framework

The researcher provided two frameworks that helped situate the current study, the Framework for 21st Century Learning (2009) and Social Constructivism (Vygotsky, 1978). The Framework for 21st Century Learning (2009) articulates the identification of skills needed for student success in the workplace. The social constructivism framework lays the theoretical groundwork to determine if SWD will perform better on the 8th Grade Florida Science Assessment if the district offers more after-school STEM activities and the students benefit from social interactions during participation in the activities.

The researchers at Partnership for 21st Century Learning (P21) authored the Framework for 21st Century Learning which focused on building collaborative partnerships among education, business, community, and government leaders. The Framework for 21st Century Learning (2009) identified mastery of fundamental subjects as important for finding jobs and remaining employed. Specifically, the science disciplines were identified. The framework facilitates student mastery through three skill sets (a) Learning and Innovation Skills, (b) Life and Career Skills, and (3) Information, Media, and Technology Skills.

Students with disabilities can benefit from the Framework for 21st Century Learning through mastery of science content knowledge. Students with disabilities must obtain content knowledge, think critically, and communicate effectively to succeed in STEM fields. If schools and districts build on this foundation, students are more engaged in the learning process and graduate better prepared for today's global economy.

Social constructivism is one of the most influential learning theories (Acedo & Hughes, 2014). It is operationally defined as the theory that social and psychological worlds are constructed through social processes and interaction (Young & Collin, 2004). This approach has been applied in several studies on science education (Pedaste, Maeots, Leijen, & Sarapuu, 2012; Pedaste & Sarapuu, 2006). Constructivist theories state that people construct knowledge based on experiences linked to personal experiences (Piaget & Garcia, 1991). Similarly, many extracurricular activities seek to replicate real world problem solving experiences (Papazian, Noam, Shah, & Rufo-McCormick, 2013).

Knowledge is derived from interactions and activities with others, like those offered during extracurricular activities (Marlow & Page, 2005). Atwater (1996) posited that learning takes place in a participation framework. Students learn by participating with others in activities and as a result of that experience they discover meanings and construct knowledge through negotiation with others. The thought is learning occurs when students create new knowledge based on background information.

To determine the appropriate framework, the researcher examined studies on informal learning and science. Many researchers used constructivism (Piaget, 1953) and social constructivism (Vygotsky, 1978) as a basis for their research. The researcher found the theories to be consistent with the underlying thought that learning in an informal environment will engage students quest for knowledge and they will be able to express their knowledge on a standardized science examination. The researcher also used the social constructivism and Framework for 21st Century Learning (2009) to guide the selection of variables in the current study. Situated within the two frameworks, the researcher will add to the limited research on STEM activities and SWD performance on standardized science assessments.

Summary of Methodology

The researcher employed an exploratory study using a convenience sample with single survey administration to answer the aforementioned research questions. Upon receiving Institutional Review Board approval from the University (see Appendices A and B), the researcher contacted the STEM director for the State of Florida. The STEM director agreed to participate and assisted with the development of the survey questions to be sent to each district about STEM activities and SWD. Once the questionnaire was agreed upon by the researcher and the STEM director, the STEM director sent the questionnaire link to each district Science director with instructions to forward it to STEM personnel.

Additional data for this study were obtained by accessing the FLDOE website. The FLDOE maintains data on its website on all public schools in the state. Student performance data are reported to the FLDOE annually by school districts personnel. The current study focused on assessment scores from state mandated achievement testing in science. No individual student data were used for this study by the researcher.

In addition to school reported data, the researcher administered a survey using Qualtrics on STEM activities and SWD. The Qualtrics survey was developed and piloted prior to the current study. The researcher used feedback from pilot participants as well as experts in the field of STEM and special education to develop the final survey questions. Validity and reliability of the instrument were evaluated by the researcher using guidelines advocated by Dillman, Smyth, & Christian (2014). Face, content, and construct validity of the survey are explained in greater detail in Chapter 3, Methodology. After gathering district level science score data related to students with and without disabilities, the researcher analyzed results using an independent *t* test, descriptive statistics, and a series of Pearson Correlation procedures. The following chapters report the findings of the analyses.

Definition of Key Terms

Correlational Study

A correlational study occurs when the purpose is to discover the relationships between variables through the use of correlational statistics. The correlation coefficient (*r*) indicates the strength and direction of the relationship (Gall, Gall, & Borg, 2007). The range of a correlation coefficient has a value between -1 and +1. A coefficient of +1 indicates the two variables are perfectly and positively correlated, so as one variable increases, the other increases by a proportionate amount. Conversely, a coefficient of -1 indicates a perfect negative relationship (Field, 2013).

Extracurricular Activities

Extracurricular activities are activities that can be done by students in a school but that are not part of the regular schedule of classes (Merriam-Webster, 2016).

Informal Learning

Learning that is predominantly unstructured, experiential, and non-institutionalized or outside of the traditional classroom (Schurmann & Beausaert, 2016).

Science, Technology, Engineering, and Mathematics (STEM) Activities

Science, Technology, Engineering and Mathematics activities include learning activities where inquiry based learning takes place under the direction of a mentor, coach, or teacher. Examples of STEM activities, as provided by stemcareers.com (2016), include robotics competitions (i.e. For Inspiration and Recognition of Science and Technology [FIRST], Best, Vex), STEM clubs (i.e. Science, Engineering, Communication, Mathematics, and Enrichment [SECME], science, engineering, coding), design challenges (i.e. solar car, astronaut), and STEM competitions (i.e. Science Olympiad, Math Olympics, Odyssey of the Mind).

Soft Skills

Soft skills are a term for a complex system of traits and habits commonly required by employers. They are the abilities and traits that pertain to an individual's behavior rather than their technical knowledge (Moss & Tilly, 2001). Some examples of soft skills can include integrity, taking another's perspective, daily pleasantries, the ability to compromise effectively, and collaboration within a group.

Standardized Test

Standardized tests are administered uniformly at different locations (Oosterof, 1999). According to the Glossary of Education Reform (2016), a standardized test is any form of test that requires all test takers to answer the same questions, or a selection of questions from a common bank of questions, in the same way, and is scored in a consistent manner, which makes it possible to compare the performance of individuals or groups of students.

Students with Disabilities

According to the IDEA (2004), the definition of a child with a disability means a child has been shown to have (a) an intellectual disability, (b) hearing impairment, (c) a speech or language impairment, (d) a visual impairment, (e) a serious emotional disturbance, (f) an orthopedic impairment, (g) autism, (h) traumatic brain injury or (i) other health impairment, (j) a specific learning disability, (k) deaf-blindness, or (l) multiple disabilities, and who, by reason thereof, needs special education and related services. Students with disabilities (SWD) for the purposes of the current study are defined as students who have mild, high incidence disabilities which include specific learning disabilities, mild intellectual disabilities, communication disorders, emotional or behavioral disabilities, and autism without intellectual disability.

CHAPTER TWO: LITERATURE REVIEW

Chapter Overview

In this chapter, the researcher begins with a discussion of informal STEM learning. Next the researcher discusses the characteristics of students with high incidence disabilities and curricular approaches that lead to enhanced science performance. The theoretical framework was determined by the researcher by a systematic review of the literature using the constructs of SWD, extracurricular activities, and science. The researcher also provided current National Science Foundation (NSF) and Institute of Education Science (IES) funded projects. Next, the researcher explains Next Generation Science Standards (NGSS) and International Society for Technology in Education (ISTE) standards. This is followed with data that illuminates the achievement gap between SWD and their non-disabled peers in science. Lastly, the researcher acknowledges the need for additional research in informal STEM learning environments.

Informal Learning Environments and SWD

Educators are turning to informal learning environments to introduce STEM related concepts to students (Denson et al., 2015). Informal learning environments, such as extracurricular STEM activities, can expand skills, develop literacies, and build social networks

(Hargittai, 2011). An example of an after-school science activity is For Inspiration and Recognition of Science and Technology (FIRST) robotics competitions.

Students with disabilities are attracted to science activities like robotics (Howard & Park, 2014). Additionally, SWD depend on hands-on, inquiry-based instruction to access science content (Melber, 2004). Melber and Brown (2008) remind us that personally relevant topics are critical for engaging SWD in science learning. Maroney, Finson, Beaver, & Jenson, (2003) advocated for creating science experiences that make SWD feel emotionally safe and have the freedom to pursue investigations without unnecessary teacher evaluation or interference in the learning process. Falvey (2005) reported educators must believe (a) in student's capacities; (b) highlight student's strengths, gifts, and talents; and (c) SWD are competent in order for successful informal learning to take place.

Papert (1980) laid the groundwork for robotics in the classroom in the 1970s. Papert believed students gained a sense of power over technology because they could identify with concrete robots. Nourbakhsh and colleagues (2005) further stated students understand abstract concepts and gain a more functional level of understanding by testing scientific and mechanical principles with robots. Barker and Ansorge (2007) and Beer, Chiel, and Drushel (1999) found students come up with creative solutions to problems in informal learning environments rather than recite answers they learned in a formal class by rote.

Students who learn to engineer robots also learn about complex system interactions, which are important lessons for computer scientists, biologists, doctors, or anyone who will need to understand complex systems (Beer et al., 1999). In 2003, Fagin and Merkle reported the effectiveness of robotics in both learning and motivation. Further studies report robotics generate a high degree of student interest and engagement in mathematics and science careers (Barnes, 2002; Robinson, 2005; Rogers & Portsmore, 2004). Further studies on robotics document the positive use of robotics to teacher a variety of students and subjects. Robotics promotes learning scientific and mathematic principles through experimentation, cooperative learning, and problem solving (Mauch, 2001; Nourbakhsh et al., 2005; Roberts & Portsmore, 2004). To guide the reader, the researcher will give an example of using extracurricular robotics competitions to help students learn STEM.

For Inspiration and Recognition of Science and Technology (FIRST) is a program where teams of students from kindergarten through twelfth grade compete as a team to design, build, and program robots (USFIRST.org, 2016). Students with disabilities might participate in a science activity like FIRST robotics. Leaders at FIRST have a history of including SWD due to the overarching theme of *gracious professionalism* where students are rewarded for helping each other, as well as other teams. Diversity within FIRST is valued by FIRST staff, coaches, mentors and volunteers. As a result, SWD are welcome and encouraged to join teams.

Within the team environment, more experienced students are asked to mentor newer students. Mentors have been shown to increase STEM performance and persistence (Holland, Major, & Orvis, 2012). Examples of roles on FIRST robotics teams include mechanical development, business, marketing, finance, programming, and an awards submission team. Students are encouraged to participate in training and webinars provided by the FIRST organization to fulfill their roles. As the season continues, students work together to design, build, program, compete, and present their robot at competitions. All team members participate in most aspects of the program. Specifically, a student who is a driver, participates in the awards presentations and the planning and building of the robot. Most students take on more than one role within a team.

As a result of participation in an informal extracurricular activity like FIRST robotics, it is the researcher's hypothesis that SWD will perform better on the 8th grade Florida Science Assessment. However, there is a dearth in the literature about SWD and their participation in extracurricular activities. Consequently, the researcher will evaluate whether there is a correlation between the number of STEM activities offered per district and the 8th grade standardized science scores of SWD in the state of Florida.

Characteristics of Students with High Incidence Disabilities

For the purpose of this study, SWD were defined as students who have mild or high incidence disabilities. High incidence disabilities include learning disabilities, mild intellectual disabilities, communication disorders, and emotional or behavioral disorders and account for more than 70% of students served in special education (Sabornie, Evans, & Cullinan, 2006). Students with mild disabilities are further defined as students who are not cognitively delayed but may have autism, learning, emotional, or behavioral disabilities. According to the 36th Annual Report to Congress on the Implementation of IDEA (2015), the total number of students ages 6 through 21 served in special education was 5,847,624 which is 8.5% of the resident population. The most prevalent disability category served under IDEA was specific learning disability (39.5%) followed by speech or language impairment (17.9%), and other health impaired (13.8%). If students in these three categories were considered mild the national population would equate to 71.2% of all SWD.

The population has grown as shown by researchers at the National Center for Education Statistics (NCES) who reported students with high incidence disabilities represented 6.6% of the school-aged population and 5% of all students who receive special education services (Aud et al., 2012). According to the NCES (2014) report, the number of SWD increased by nearly 1 million students between 2013 and 1014. Due to this growth, legislators at the federal level continue to fund research on SWD through the Institute of Education Sciences (IES) and the National Science Foundation (NSF).

Current Funded Projects and Publications

Institute of Education Sciences

To determine current funded projects from the Institute of Education Sciences (IES), the researcher used the search terms "informal, after-school, science, k-12, and disability" on the IES funding opportunities website. The researcher found a total of 722 records and downloaded the title, program, principal investigator (PI), awardee, goal, year, and center into an Excel spreadsheet. Next, the researcher filtered the records by year and only selected active grants. The

researcher found 134 active grants. In the next phase, the researcher filtered the 134 grants using the word “disability” in the Excel keyword search box. There are currently 18 funded projects related to SWD from the Institute of Education Sciences (IES). The researcher reviewed the titles and abstracts and further reduced the number to 10. Grants were eliminated by the researcher from the findings if they focused on pre-school, severe disabilities, or a non-STEM construct (i.e. reading). Each IES project is summarized in Appendix C, Table 28. Figure 1 is an overview of the search process for IES
grants..

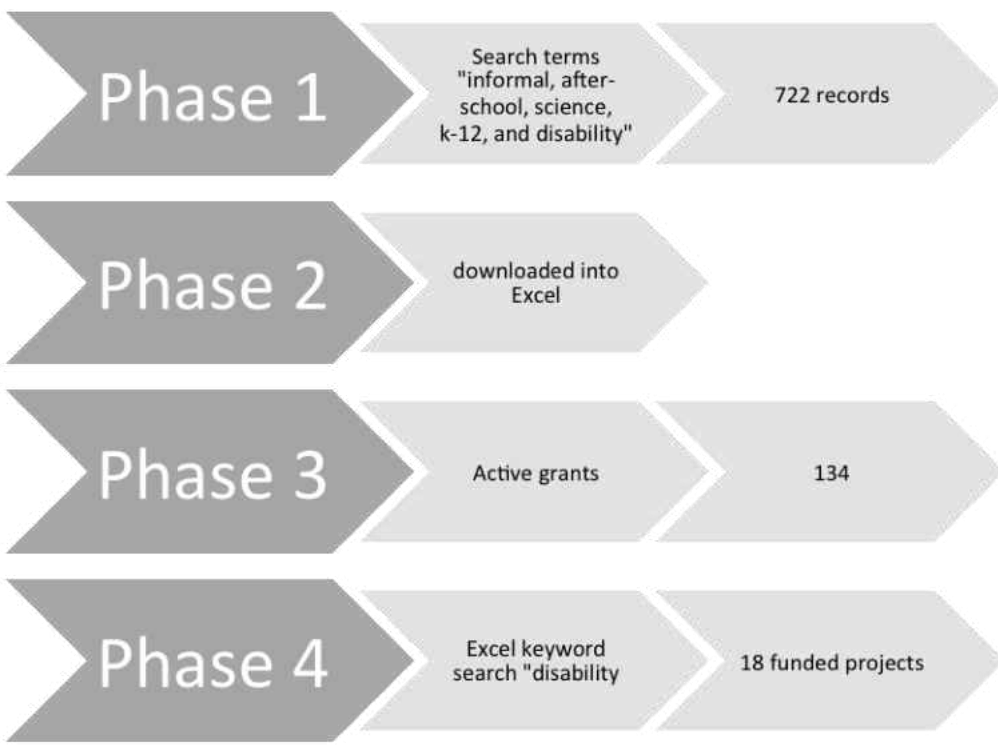

Figure 1. IES Search Process

A summary of the IES grant topics include:

- Expanded learning time
- College and career standards
- Literacy outcomes for middle school students
- Career development for girls with disabilities
- Using multimedia to improve middle school science vocabulary
- Peer support for parents of middle school SWD
- Middle school mathematics tools
- Science learning difficulties
- Predictors of postsecondary outcomes for SWD

National Science Foundation

Researchers from the National Science Foundation (NSF) reported 10% of STEM students entering postsecondary education have a disability (Burrelli, 2007; Leddy, 2010). As a result, the NSF created the Research in Disabilities Education (RDE) program, and is under the Directorate of Education and Human Resources – Division of Human Resource Development – Research in Disabilities to fund educational research studies on evidence-based practices in order to increase the participation and achievement of SWD in STEM fields. The researcher conducted a search of all active NSF awards using the keywords disability, science, “middle school” and informal. International grants were filtered out which resulted in 348,151 awards. The NSF site sorted the results by relevance. The researcher additionally noticed many of the awards were not active, but had end dates before June of 2016. As a result, the researcher read the award abstract for each award with a relevance score of 65 or higher (n = 63) as determined by NSF. The researcher further filtered the awards by title and abstract. The researcher discarded non-active awards and awards without the constructs of interest which left 15 NSF funded projects. Each project is summarized in Appendix C, Table 29. Additionally, principal investigators and co-principal investigators published 10 studies related to the current funded projects from both NSF and IES. The publications are summarized in Appendix C, Table 30. Figure 2 is an overview of the search process for NSF grants.

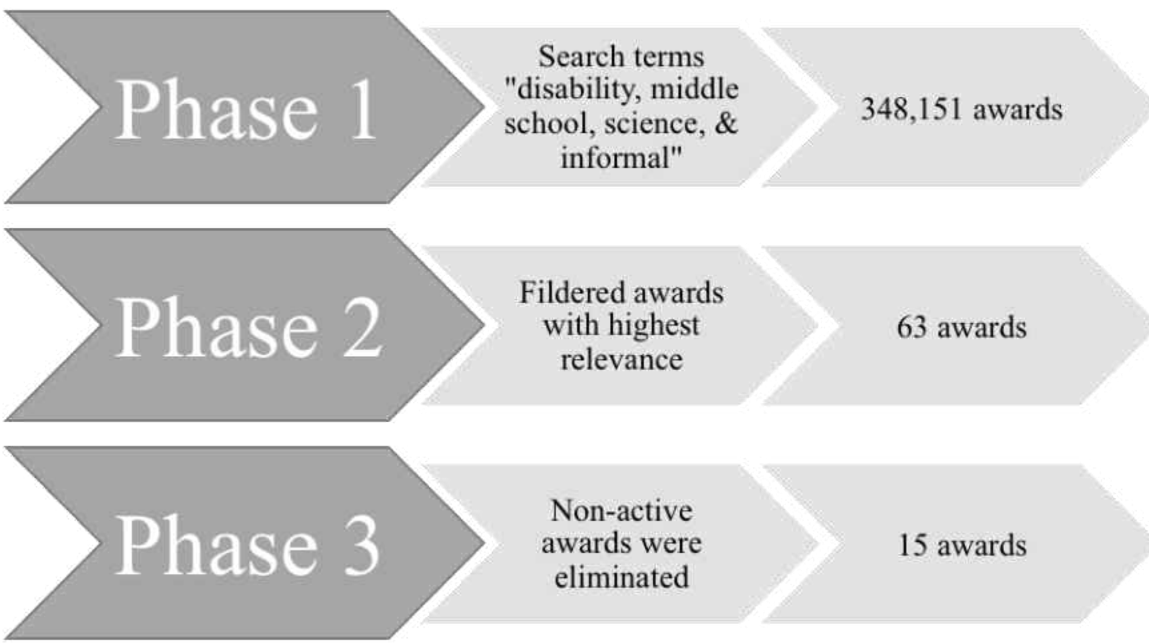

Figure 2. NSF Search Process

A summary of NSF award topics includes:

- Assistive technology
- Self-regulation
- Natural language
- Accessible simulation
- Workforce participation
- Online learning
- Persistence
- Alabama Alliance for SWD in STEM
- Marginalized STEM workforce

The cumulative projects from NSF and IES report the standard postsecondary accommodation for SWD who study STEM is accessible information technology and assistive technology (Leddy, 2010). For example, Burgstahler, Moore and Crawford (2010), reported students pursuing STEM degrees in the University of Washington's AccessSTEM Alliance had access to technology in project activities. Additionally, Collins, Hedrick, and Stumbo (2007) reported on the importance of offering state of the art technology for SWD to be successful in STEM. In spite of these reports, Leddy (2010) stated the use of assistive technology in science labs is still not as high as it should be to create equally accessible experiences for SWD pursuing STEM careers. As a result, the Georgia Institute of Technology's Center for Assistive Technology and Environmental Access and the University of Washington's Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Center are developing web based dissemination mechanisms of their research efforts (i.e., http://www.washington.edu/doit/RDE/) (Leddy, 2010). As new technology is introduced, there is a critical need for studies to investigate which interventions have the highest impact on high school graduation rates for SWD and their entrance into STEM degree programs (Leddy, 2010). Not only is assistive technology imperative for the success of SWD, engaging students in the way they learn through differentiated curriculum can lead to increased STEM performance. To assist teachers and administrators in educating students to succeed in STEM, the Next Generation Science Standards (NGSS), National Educational Technology Standards (NETS), and the National Engineering Standards (NES) were developed by policy makers, industry professionals, and educators.

The Next Generation Science Standards

Science, Technology, Engineering, and Mathematics (STEM) education represents a symbiotic relationship among the four interwoven fields of study (Marino, Fisher, & Gallegos, 2014). Every aspect of modern life is impacted by STEM and K-12 students should have opportunities to participate in STEM activities in all of their courses (National Science Foundation [NSF], 2012). The interdisciplinary nature of STEM is referred to as crosscutting concepts in the Next Generation Science Standards (NGSS), which provide national guidance for science instruction. The National Research Council (NRC; 2012) points out that each aspect of STEM should be integrated into standards, curriculum, instruction, and assessment to be meaningful to students.

The Next Generation Science Standards (NGSS) were authored by members of the NRC, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve, Inc. The Next Generation Science Standards (NGSS) provide the building blocks for teaching science and include a framework across three dimensions (a) scientific and engineering practices, (b) crosscutting concepts that unify the study of science and engineering through their common application across fields, and (c) disciplinary core ideas (NGSS, 2014). All three dimensions need to be integrated into standards, curriculum, instruction, and assessment to be meaningful to students when learning science and engineering (NRC, 2012). The framework is intended to be a guide to standards developers, curriculum designers, assessment developers, state and district science administrators, professional development for science educators, and science educators working in informal settings (Achieve, 2010). The NGSS framework began with a developmental progression, focused on a limited number of core ideas, and emphasized learning about scientific explanations and practices needed for scientific inquiry and engineering design (NGSS Lead States, 2013).

The crosscutting concepts provide an organizational schema connecting knowledge from various science disciplines into a lucid and scientifically-based view of the world (NRC, 2012). The seven concepts are (a) patterns; (b) cause and effect; (c) scale, proportion, and quantity; (d) systems and system models; (e) energy and matter; (f) structure and function; and (g) stability and change (NRC, 2012). Crosscutting concepts will enable students to actively engage in science and engineering practices over multiple years of school to deepen their understanding of core ideas (NGSS Lead States, 2013).

The authors of the NRC report describe the need to strengthen engineering in school to stress the importance of STEM in students' daily lives (National Academy of Engineering, 2010). For example, students should not only know how to use the technology around them but have an understanding of why the technology works and the necessary steps needed to create new technology. Additionally, the crosscutting concepts enable students to have a practical understanding of science and engineering (Achieve, 2013). Science and engineering are emphasized to reflect the importance of understanding the human-built world and to recognize the value of teaching and learning science, technology, and engineering (NCS, 2012). Every aspect of modern life is impacted by science, technology, and engineering and students throughout grades K-12 should have the opportunity to carry out scientific investigations and engineering design projects like those offered in STEM activities (National Academy of Engineering, 2010). Engineering and technology are emphasized because the NRC committee found substantive evidence that student exploration and practical use of science led to significant learning gains (NRC, 2012). In fact, funding agencies, teachers, and researchers devote a great amount of time and resources toward enhancing access to STEM education materials using technology (U. S. Department of Education, 2010).

Within the NGSS, eight practices were deemed as essential elements to the K-12 science curriculum. Those practices are (a) asking questions and defining problems; (b) developing and using models; (c) planning and carrying out investigations; (d) analyzing and interpreting data; (e) using mathematics and computational thinking; (f) constructing explanations and designing solutions; (g) engaging in argument from evidence; and (h) obtaining, evaluating, and communicating information (FLDOE, 2012). By the time students graduate, they should be able to engage in public discussions of science related issues, be critical consumers of scientific information, and continue to learn about science throughout their lives (NRC, 2012). Many educators, coaches, and mentors incorporate NGSS practices into extracurricular STEM activities. In addition to NGSS, engineering standards were developed by organizations like the International Society for Technology in Education (2007) and the National Academy of Engineering (2010).

International Society for Technology in Education National Engineering Standards

Like NGSS, the International Society for Technology in Education (ISTE) published the National Educational Technology Standards (NETS) in 1998 as a resource for teachers, curriculum and learning resources developers, other standards bodies, school leaders, students, parents, policy-makers, and the business community (Stager, 2007). In 2007, ISTE published a list of updated standards to include (a) creativity and innovation; (b) communication and collaboration; (c) research and information fluency; (d) critical thinking, problem solving, and decision making; (e) digital citizenship; and (f) technology operations and concepts. Like NGSS, educators, coaches, and mentors incorporate these standards in many extracurricular STEM activities.

National Engineering Standards

In 2010, a group of experts commissioned by the National Academy of Engineering assessed the potential value and feasibility of developing and implementing content standards for engineering education for the K-12 student population. While standards had been developed for science, mathematics, and technology, engineering had no equivalent (Katehi, Pearson, & Feder, 2009). Additionally, Katehi and colleagues (2009) could not determine the precise number of United States K-12 students who had been exposed to engineering related coursework or the number of teachers involved in K-12 engineering education. Prior to 1990, almost no curricula or programs on engineering were available (Katehi et al., 2009).

The committee wrote three guiding principles (Katehi et al., 2009). The first is K-12 engineering education should emphasize the engineering design process. The second is engineering education should incorporate developmentally appropriate mathematics, science, and technology knowledge and skills. The last principal is engineering education should promote engineering habits of mind which include (a) systems thinking, (b) creativity, (c) optimism, (d) collaboration, (e) communication, and (f) attention to ethical considerations.

The Committee on Standards for K-12 Engineering Education concluded it would be difficult to ensure usefulness and effectiveness of engineering standards for several reasons (National Academy of Engineering, 2010). First, there were limited experiences with K-12 engineering education. Second, there were few teachers qualified to teach engineering. Third, standards-based educational reforms lacked evidence of impact, and lastly, there were significant barriers for introducing standards in a new content area (National Academy of Engineering, 2010). However, ancillary supports such as after-school clubs may support this type of learning (Diaz & Cox, 2012). After reviewing NSF, IES, NGSS, NES, and ISTE the researcher focused on middle school students because middle school is where most higher level course selection is made. Furthermore, the researcher focused on informal STEM learning through extracurricular activities because of the benefits associated with extracurricular activities are well documented in the literature (Logan & Scarborough, 2008; Fredericks & Eccles, 2006).

Students with Disabilities Lag Behind Their Peers in Science

A sustained statistically significant achievement gap is evident between SWD and their nondisabled peers in science. For example, on the 2011 National Assessment of Educational Progress (NAEP) in 8^{th} grade science, a significant difference on the scaled scores of SWD (M = 122, SD = 38) and students without disabilities (M = 155, SD = 32); p = 0.00 was evident. On the 2009 NAEP 8^{th} grade science assessment, there was a significant difference on the scaled scores of students with disabilities (M = 121, SD = 39) and students without disabilities (M=153, SD = 33); p = 0.00 (National Center for Education Statistics [NCES], 2011). See Figure 3 for an overview of 8^{th} grade NAEP science scores.

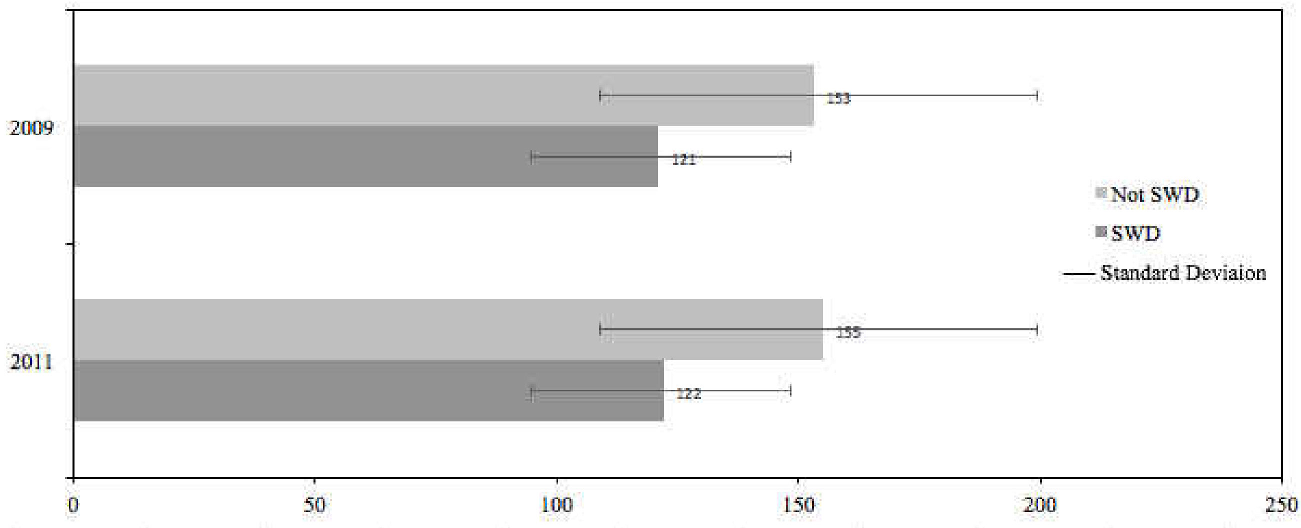

Figure 3. NAEP Science Scores

Historically, SWD have underperformed on science achievement tests. Using the National Educational Longitudinal Study (NELS) data, Anderman (1988) reported students with learning disabilities scored one standard deviation lower on science achievement than their peers without disabilities. From NAEP data in 2000, SWD also scored nearly one standard deviation below students without disabilities in the 4th, 8th, and 12th grades (NCES, 2005). As noted previously, the 2009 and 2011 NAEP 8th grade science scores of SWD are nearly one standard deviation below students without disabilities. Consequently, many SWD have a history of scoring below two-thirds of students without disabilities on the 8th grade NAEP science assessment. As a result, educators and policymakers continue to search for programs to close the science achievement gap between SWD and their non-disabled peers.

Reasons for the Achievement Gap in Science

There are many reasons SWD do not grasp science content. In the next section, the researcher discusses the literature on reading, executive functioning, and lack of procedural skills. Furthermore, literature on general education science teachers, assistive technology, and accommodations are discussed.

Not only are many SWD scoring below basic level on the NAEP science assessment, they are not meeting grade level standards across STEM content areas (NCES, 2005). All students face increased demands beginning in fifth grade because the learning materials become more abstract and there is a change from narrative to expository text structures (Dexter & Hughes, 2011; Graesser, McNamara, & Kulikowich, 2011; Gajria, Jitendra, Sood, & Sacks, 2007). Additionally, Street et al. (2012) suggested SWD often fail to meet STEM course standards due to difficulties with executive functioning (i.e., managing the cognitive processes used in planning, organizing, strategic planning, time management, and paying attention to detail). In science classes, inductive and deductive reasoning are common, yet difficult for the majority of SWD (Marino, 2010; Mastropieri et al., 2006).

Haager and Vaughn (2013) reported about the importance of educators providing sustained exposure to grade level text and effective intervention techniques for SWD, specifically learning disabilities. The reading levels of secondary students with learning disabilities (LD) often lag behind their peers as shown by lower standardized reading achievement test scores (Shapiro, 2011). Textbooks are a major source of science instruction at the high school level (Moin, Magiera, & Zigmond, 2009). Given all of these factors regarding textbooks, it is not surprising SWD have difficulty with independent reading of science texts (Moon, Todd, Morton, & Ivey, 2012; Steele, 2008). As a result, SWD need interventions to increase science scores that are not text based, like STEM activities.

After reading levels, a second issue of SWD meeting grade level standards in STEM content areas is the lack of procedural skills during inquiry activities (Marino, 2010). Educational reforms and science standards call for the teaching of science to be inquiry based (American Association for the Advancement of Science [AAAS], 1998). Students with LD require significant coaching to engage in the kind of reasoning that is typically associated with inquiry based approaches to science instruction (Moon et al., 2012). Inquiry based learning approaches often occur in after-school STEM activities (Almeida, Bombaugh, & Mal, 2006). Students with disabilities can practice these approaches with peers if they participate in STEM activities.

Scientific inquiry is a process where students question, predict, experiment, model, and apply concepts (White & Frederiksen, 1998). Students with disabilities are less likely than their peers to have a systematic plan to approach problems in formal science classes (Dalton, Morrocco, Tivnan, & Mead, 1997). Students with disabilities need more guidance than their peers to manage the information and time restrictions in a formal high school science classroom (Samsonov, Pederson, & Hill, 2006).

Inquiry activities are a means of empowering students. When inquiry activities are used to teach science, the focus shifts from the teacher to the student (NRC, 2015). Inquiry activities are considered student centered because they place some or all of the responsibility of the topic of the inquiry, designing procedure for the inquiry, determining the results of the inquiry, and evaluating and presenting the results and conclusions of the inquiry (Taylor, Therrien, Kaldenberg, Watt, Chanlen, & Hand, 2011). There is a continuum of inquiry based activities that are more or less student centered where the roles or responsibilities of the teacher move from lecture to open inquiry in formal classrooms (Dias, 2005; Eick, Balkcom, & Meadows, 2005; Jimenez, 2011). However, informal activities have more student based inquiry and less teacher lecture.

Accommodations have been shown to be successful for SWD (Cameto, Knokey, & Sanford, 2011; Campbell, Wang, & Algozzine, 2010; Carter, Prater, & Dyches, 2008). According to Stefanich (2007) accommodations in science include helping students develop stronger procedural skills, apply organizational strategies, and transfer reading and mathematics skills to the science content area. These accommodations, however, do not always address scientific thinking (Mutch-Jones, Puttick, & Miner, 2012). The increased demands on the science content can lead to frustration, academic failure, loss of access to the general education curriculum, and loss of future STEM opportunities (Basham & Marino, 2013). Furthermore, many SWD are not encouraged to take courses that enable them to become scientifically literate citizens (Burgstahler & Change, 2009). Course selection in STEM often begins at the middle school level. As a result, SWD need more encouragement to participate in informal science learning like extracurricular STEM activities to increase their science skills and self-confidence (CEC, 2001).

Many general education STEM teachers are unprepared to meet the needs of SWD (Stefanich, 2007). Montgomery and Mirenda (2014) stated teachers of students in inclusive classrooms report they lack the knowledge, skills, and confidence to make instructional adaptations for SWD. Furthermore, the adaptations made were not consistent, systemic, or as frequent as needed (Montgomery & Mirenda, 2014). In 2012, Marino and Hayes stated science teachers lack instructional diversity and have inadequate knowledge of effective pedagogical practices for teaching SWD. As a result, there is a need to research different pedagogical approaches for educating SWD to become scientifically literate citizens.

Teachers may not be aware of technologies and strategies available to help them accommodate SWD or they lack the supports and resources necessary to make pedagogy accessible (Stefanich, 2001). For example, Villanueva and Hand (2011) reported teachers often focus on a rigid interpretation of the scientific method which involves multistep problems with limited supports. Additionally, many STEM teachers use didactic instruction, lab experiences, and STEM texts in their instruction and fail to make sure the content is accessible or even appropriate for the abstract concepts difficult for SWD (NRC, 2011). Unfortunately, there is not a full understanding of how to best support diverse learners in accessing STEM curricula (Israel, Maynard, & Williamson, 2013). Consequently, SWD are disenfranchised from STEM fields and more research is needed on educating SWD in STEM content areas.

Informal learning through extracurricular STEM activities can provide successful science learning through inquiry (Sacco, Falk, & Bell, 2014). Inquiry activities empower students so they may become active agents of their education. Inquiry and problem solving approaches to learning are motivators for student learning (Cooper & Heaverlo, 2013). The team competition structure of many extracurricular STEM activities results in naturally occurring problem-solving, highly creative, resource-based, hands-on science learning communities of student, parent volunteers, and teacher coaches (Raju & Clayson, 2010). Another skill extracurricular activities can help SWD develop is self-efficacy and self-determination (Seow & Pan, 2014).

Self-efficacy and Self-Determination in STEM

In order to be successful in STEM careers, SWD must develop self-efficacy and self-determination skills. In 1997, Bandura wrote self-efficacy is the "belief in one's capabilities to organize and execute the course of action required to produce given attainment" (p.2). There are four factors to a students' sense of self-efficacy; mastery experiences, vicarious experiences, social persuasion, and self-management (Bandura, 1994). Additionally, positive prior experiences which result in positive outcomes increase confidence and willingness to persist when faced with challenges (Bandura, 1997; Schunk & Pajeres, 2009). Resilience, perseverance, and stress to perform a daunting task is reduced when a student sees a similar peer succeed through vicarious experiences (Bandura, 1997; Jenson, Petri, Day, Truman, & Duffy, 2011; Schunk & Pajares, 2009). Because self-efficacy beliefs are malleable, they can be changed through social persuasion (McNatt & Judge, 2008). Teachers, parents, and peers can boost confidence resulting in a student who is more likely to put forth and sustain greater effort (Jenson et al., 2011). Within the field of STEM, SWD reported an increase in self-confidence when seeing other SWD succeed (Jenson et al., 2011). Organizers of after-school STEM activities can promote an increase in self-confidence by actively recruiting SWD to participate in their programs.

Not only is self-efficacy a problem for SWD, many SWD who wish to pursue postsecondary education in STEM need support in self-advocacy and self-determination skills (Grigal & Hart, 2010). Self-determination skills are needed to effectively advocate for needed accommodations (Izzo, Murray, Priest, & McArrell, 2011). Additionally, Test and colleagues (2009) found in a systematic review of the literature that self-determination skills in high schools were a predictor of post school education and independent living skills. Students with disabilities need to develop self-determination and self-advocacy skills to meet the demands of STEM degrees and careers (Izzo et al., 2011). Another skill needed by SWD to persist in STEM careers is soft skills.

Students with Disabilities Need Soft Skills to Succeed

Special educators often deliver social skills instructions to change the behavior of students in self-contained environments (Miller, Lane, & Wehby, 2005). The skills are taught by breaking the task down into steps then incorporating discussion, modeling, roleplaying, reinforcement, problem solving, and feedback (Elliott & Gresham, 2007). However, many teachers, including science teachers, do not feel prepared to promote positive peer interactions (Dee, 2011). Within after-school STEM activities, coaches naturally promote positive interactions through teamwork and collaboration in a supportive environment. Thus, rather than prescriptive direct instruction using different types of curriculum, the goal of most STEM activities are team based competitions. The outcome is not an individual grade or accomplishment of an Individual Education Program goal or objective, but to win a competition or award.

Social skills in the workplace are often called soft skills. Robinson and Stubberud (2014) described soft skills as thinking in a creative way, thinking critically, networking, and working in teams to improve a program. Green and Blaszczynski (2012) described soft skills as personal qualities, habits, attitudes, and social graces that make someone compatible to work with and a good employee. Those soft skills include teamwork, communication, leadership, customer service, and problem solving skills. According to De Ridder, Maysman, Oluwagbemi, and Abeel (2014) soft skills are defined as the social behaviors needed to become successful in the workplace. Attributes of soft skills include friendliness, empathy, and optimism (Heckman & Kautz, 2012). In other words, people who have a strong work ethic and work well in a team have soft skills. Soft skills are hard to acquire through reading and it is recommended they are learned through practice or informal learning environments. Informal learning environments like after-school STEM activities give SWD an environment to practice and generalize soft skills needed before transitioning to the workplace.

Employers indicate soft skills are an important factor of job performance, if not more important than technical skills (Glenn, 2008). Soft skills are more difficult to teach and measure than technical skills (Loughry, Ohland, & Woehr, 2013). Industries hire individuals with strong soft skills in order to retain a competitive edge (Glenn, 2008). Employment in the United States has shifted and requires more employees to interact with others.

In STEM, successful students are not only problem solvers with high technical skills but are effective at soft skills like collaboration and communication (Brewer & Smith, 2011). Soft skills are so critical that 6 out of the 11 undergraduate student outcomes required by the Accreditation Board for Engineering and Technology (ABET) focus on soft skills (Williams, 2001). Given the importance of soft skills in the STEM workforce, it is surprising the engineering education research community does not give it more attention (Singer & Schweingruber, 2012). Since SWD who participate in extracurricular activities develop social skills and self-confidence (CEC, 2001), the researcher will examine whether STEM activities can also increase 8th Grade Science Assessment scores. In the next section, the researcher conducted and shared a review of the literature on the learning theories associated with SWD, extracurricular STEM activities, and science achievement.

Theoretical Framework Used as Basis for Study

To determine the theoretical support of using informal science activities to increase student outcomes on statewide science assessments, a review was conducted of current literature using the Thompson Reuters (ISI) Web of Science, EBSCO, and Science Direct databases. During the first stage of the search (see Table 1), the publishing period was set by the researcher from 2006 to 2016. The researcher only selected scholarly, peer-reviewed journals. The following keywords were used by the researcher: (middle school students) AND (after-school OR extracurricular activities) AND (science education). The researcher analyzed all search results by title. If a title was unclear, the abstract was reviewed by the researcher to identify whether the article discussed middle school science and extracurricular activities. During the third stage, articles were assessed in detail. To be included in stage three, the research met the following criteria:

- Extracurricular activities were used to teach science;
- The study utilized quantitative or qualitative methods;
- Teaching and learning took place during face to face interactions.

Table 1. Number of Articles Included During Each Stage of the Literature Review Process

Database*	Stage 1	Stage 2	Stage 3
ISI Web of Science	65	10	2
EBSCO	29	18	5
Science Direct	603	54	4

**Several duplicate articles were returned by all databases, the results in the third stage are unique.*

See Appendix D, Table 31 for the results of the articles selected for analysis.

The researcher identified several learning theories as a framework for the selected research. Learning theories applied in science education for middle school students through extracurricular activities are described by the researcher in Table 2 along with their operational definitions.

Table 2. Learning Theories of Research Conducted on Science and Extracurricular Activities

Name	Operational Definition	Reference
Constructivism	People construct their knowledge based on experiences gained from real world and linked to personal pre-knowledge	Piaget & Garcia (1991)
Social Cognition	The cognition of social objects, including people; the social situations people encounter and the interpersonal behaviors that transpire in those situations	Bruner & Tagiuri (1954)
Project Based Learning	Tasks assigned to students organized in teams of group work. Tasks involve investigation or are based on searches for problems	Karahoca, Karahoca, & Uzunboylu (2011)
Motivation	A return to a task at a subsequent time; in similar or varying circumstances; without visible external pressure to do so; and when other alternatives are available	Maehr (1976)
Ecological Systems	Adolescents' biological propensities, work in conjunction with multiple levels of the surrounding environment, shape their development	Bronfenbrenner (1979)
Opportunity Structure	The difference between structurally based resources, the investment people make in resources (within the constraint of available resources), and their influence on various outcomes	Charles, Roscigno, & Torres (2007)
Activity	The interactions of participants and their surroundings by using tools through activities	Vygotsky (1978)

All of these approaches follow the ideas of constructivism derived from Piaget's work (Papert, 1980; Piaget, 1953). Piaget's theory of constructivism is students learn through play.

Vygotsky, on the other hand, expanded on that theory by saying students learn through the social interactions of play. The theories are related; for example, project-based learning is the implementation of constructivism (Frangou, 2009). The movement in science education from teacher to student centered approaches came about as a result of constructivism. Mintzes and Wandersee (2005) wrote the role of the teacher in the constructivist classroom was to facilitate construction of knowledge through activities that expose the inadequacies of prior conceptions, so the student may begin through inquiry to construct conceptions of the natural world that fall within the bounds of accepted scientific theory. The theoretical framework leads to activities promoting innovative outcomes as illustrated in Figure 4.

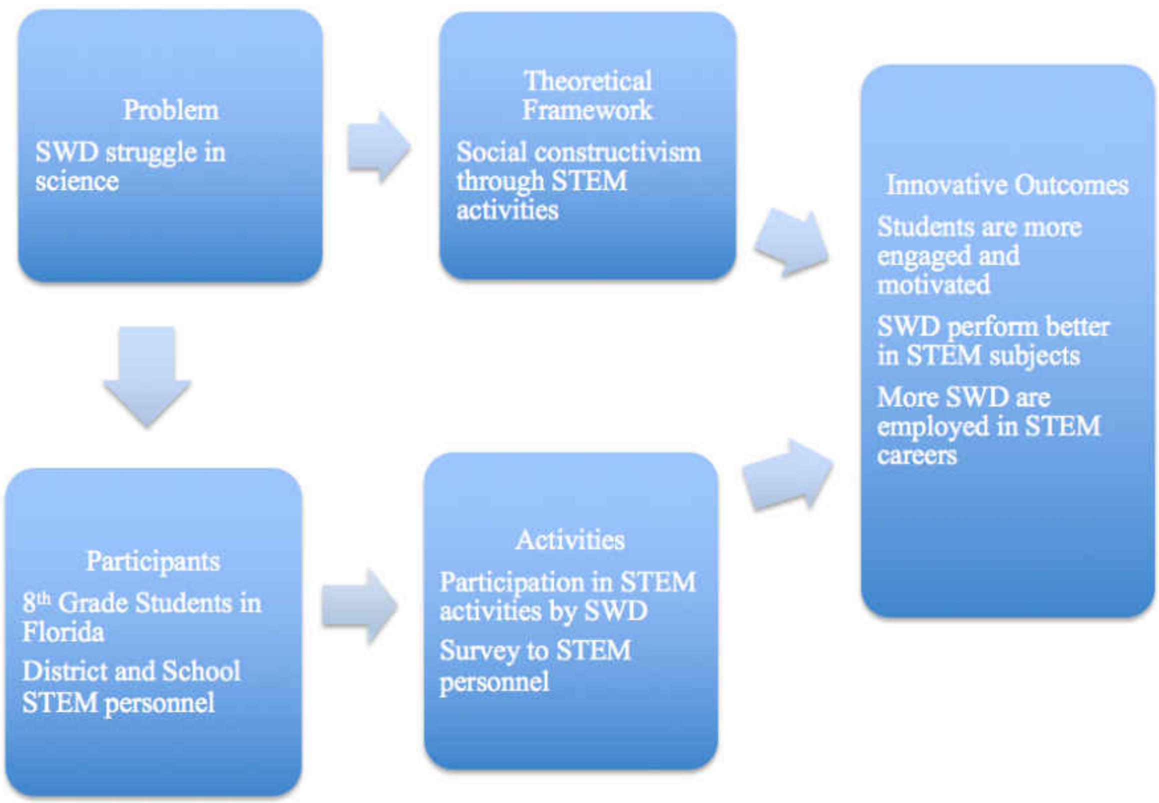

Figure 4. The Relationship among Theoretical Framework, Activities & Outcomes

Social constructivism is one of the most influential learning theories (Acedo & Hughes, 2014) and is operationally defined as the belief that social and psychological worlds are constructed through social processes and interaction (Young & Collin, 2004). Competition based learning is a methodology where learning outcomes are achieved through competitions (Altin & Pedaste, 2013). This approach has been applied in several studies on science education (Pedaste & Sarapuu, 2006; Pedaste et al., 2012). Constructivist theories state that people construct knowledge based on experiences that are linked to personal experiences (Piaget & Garcia, 1991).

Many extracurricular activities seek to replicate real world problem solving experiences (Papazian et al., 2013). As a result of the search of the literature and the importance of social and soft skills in STEM education, the theoretical learning framework the researcher used as a foundation for this study is social constructivism. The social constructivism framework addressed the hypothesis that SWD will perform better on the 8th Grade Florida Science Assessment if the district offers more STEM activities.

Knowledge is derived from interactions and activities with others, like those offered during extracurricular activities (Marlow & Page, 2005). Social constructivism in education is predominantly based on the work of Vygotsky and Piaget (Mbati, 2013). Vygotsky (1978) introduced the term zone of proximal development which refers to the way in which new knowledge is dependent on previous learning.

Vygotsky (1978) defined the zone of proximal development as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p.86). According to Mbati (2013), researchers interpret the zone of proximal development in three ways:

- Students learn best when they are within their zone of cognitive development
- Interactions with others allow students to achieve more than they can achieve alone
- Change is constant

Lave and Wenger (1991) posited learning takes place in a participation framework. For example, students learn by participating with others in activities and as a result of that experience they discover meanings and construct knowledge through negotiation with others. The thought is that learning occurs when students create new knowledge based on background information. Background information is needed to elicit prior knowledge, which is the first stage of constructivism according to Mbati (2013). Mbati (2013) argued that knowledge is constructed through social interactions. People learn material more efficiently when they are allowed to interact with their peers. Furthermore, employers value social interaction and collaboration.

Industries hire individuals with strong collaboration and social skills also known as soft skills (Glenn, 2008). In 2013, the American Institutes of Research (AIR) reported on predictors of postsecondary success. The attributes the AIR authors identified as important for employment and college include collaborative skills. More predictors include persistence, emotion regulation, and attentiveness (Hair, Halle, Terry, Lavelle, & Calkins, 2006). Given the importance of science, social, and soft skills in today's workplace, the researcher will examine the relationship between the number of STEM activities offered in Florida school districts and compare them to SWD achievement levels on the 8th Grade Florida Statewide Science assessments.

College and Career Readiness

The Department of Education (DOE) has identified college and career readiness as an initiative for the Every Student Succeeds Act (2015). College and career readiness was introduced in *A Blueprint for Reform* in 2010 and refers to the goal of preparing every student for success in college and career. The authors of *A Blueprint for Reform* (2010) wrote the components of college and career readiness include: (a) rigorous standards, (b) assessments that measure college and career readiness standards, and (c) a curriculum that encompasses all content areas necessary in preparing students to contribute to the global marketplace. The researcher will discuss college and career outcomes for SWD in the next section.

College and Career Outcomes for Students with Disabilities

Science standards for middle school students have become more intensive and less broad than elementary science standards (NRC, 2010). Middle school students are required to know the nature of matter, natural environments, interactions between organisms, and demonstrate concrete connections with scientific methodology using the scientific methods (NRC, 2010). Once the students reach high school, they are required to specialize in narrowed scientific disciplines, mainly natural sciences (Larkin, Seyforth, & Lasky, 2009). Furthermore, students in the middle school are at a critical time in their educational career where they are expected to articulate a future career identity (Hartung, Porfeli, & Vondracek, 2008; Kesidou & Roseman, 2002).

High school graduation requirements have increased with a goal of improving student learning through state mandated accountability standards (Johnson, Thurlow, & Schuelka, 2012). The more stringent graduation requirements have impacted and challenged SWD (Johnson, et al., 2012). The increase in requirements have caused some students to drop out of school (Johnson & Johnson, 2000). Students who do not graduate have limited career and college opportunities

(Zhang & Law, 2005). According to National Center for Education Statistics (2013), the graduation rate was 3.1 million or 81% of all high school students compared to 61% for SWD in the school year 2011-12. Students who participate in extracurricular STEM activities have a higher graduation rate than students who do not participate in after-school activities or clubs (Durlak, Weissberg, & Pacan, 2010).

Not only are SWD not graduating from high school at the rate of their non-disabled peers, they are not employed at the same rate as people without disabilities. The U.S. Bureau of Labor Statistics (2013) reported only 17.1% of persons with disabilities are employed as compared to 64.6% of people without disabilities. Furthermore, persons with disabilities are less likely to complete a bachelor's degree and more likely to be employed part time than their peers without disabilities (Newman et al., 2011). Employment by SWD in the STEM occupations is even less than the general population (Leddy, 2010).

Science, Technology, Engineering, and Mathematics

In many countries, including the U. S., an economy based on the understanding of STEM is replacing traditional manufacturing (Kaku, 2011). Unfortunately, the U.S. is ranked 20th in science on the latest Program of International Student Assessment (NCES, 2012). Across the world there is clear evidence of a significant need for students who have an understanding of STEM and the diverse range of associated careers (National Science Board, 2016).

Science, technology, engineering and mathematics education plays a critical role in shaping culture and economic development through innovation (Cooper & Heaverlo, 2013). To be successful during STEM learning experiences, students must move beyond low-level cognitive tasks and gain a foundational understanding of the content (Marino et al., 2014). A meaningful STEM program encourages students to develop solutions that incorporate a variety of disciplines (Basham et al., 2010). Educators can create engaging learning environments where students are encouraged to identify and solve problems (Marino, Israel, Beecher, & Basham, 2014). Students benefit when they work collaboratively to develop solutions across subject areas (Schroeder, Scott, Tolson, Huang, & Lee, 2007). Examples of STEM activities include robotics competitions (i.e. For Inspiration and Recognition of Science and Technology [FIRST], Best, Vex), STEM clubs (i.e. Science, Engineering, Communication, Mathematics, and Enrichment [SECME], science, engineering, coding), design challenges (i.e. solar car, astronaut), and STEM competitions (i.e. Science Olympiad, Math Olympics, Odyssey of the Mind).

Due to barriers to access STEM programs, SWD have been historically excluded from postsecondary STEM education (Burgstahler, 1994; Burgstahler & Chang, 2009; Moon et al., 2012). In fact, according to the U.S. Census data (2012), people with disabilities constitute 10% of the nation's general workforce, but only 2% of its STEM professionals. The reason for the exclusion is barriers to access STEM programs discussed previously by the researcher and include reading levels of SWD, lack of inquiry and procedural skills, as well as lack of executive functioning skills. Therefore, it is imperative researchers and educators develop programs for SWD to overcome these barriers for SWD to participate in postsecondary STEM education.

Informal Science, Technology, Engineering, & Mathematics Learning

Denson and colleagues (2015) reported a need for reform in Science, Technology, Engineering, and Mathematics (STEM) education to attract a more diverse workforce. Watson and Froyd (2007) stated a diverse population in STEM careers impacted the level of creativity, innovation, and quality of STEM products and services. However, many STEM learning environments are formal and fail to introduce underrepresented students to STEM professions (Denson et al., 2013). Furthermore, researchers have recognized the importance of informal learning environments that will be instrumental to the reform of STEM education (NRC, 2015).

Chubin, May and Babco (2005) postulated an effective informal learning environment in STEM must (a) promote awareness of engineering, (b) provide academic enrichment, (c) have trained and competent instructors, and (d) be supported by the educational system of the student participants. Informal learning environments are categorized into (a) everyday experiences, (b) designed settings, and (c) programmed settings (Kotys-Schwartz et al., 2011). As noted previously, informal learning environments typically take place outside of the traditional classroom environment and have been an integral part of education for years (NRC, 2015). Informal learning environments associated with school are often called extracurricular activities.

While science education often focuses on curriculum and teacher professional development, learning in non-school settings is often overlooked (Bell, Lewenstein, Shouse, & Feder, 2009). Every year millions of Americans explore informal learning institutions (i.e.

science centers and museums) to pursue their interests (Bell et al., 2009). Informal science learning and community-based organizations include libraries, schools, think tanks, institutions of higher education, government agencies, private companies, and philanthropic foundations. Informal environments include a family discussion at home, visits to museums, nature centers, or other designed settings and every day activities like gardening. Informal learning environments include participation in clubs and recreational activities like hiking and fishing. Science enthusiasts who organize themselves into community based organizations stimulate the science specific interests of students (Bell et al., 2009). As a result of the need for reform in STEM education, the Committee on Successful Out of School STEM Learning was established by the Board of Science Education to examine the potential of non-school settings for science learning (NRC, 2015).

The committee found evidence that individuals of all ages learn science across many venues. Furthermore, out of school programs have been shown to (a) contribute to student's interest in and understanding of STEM, (b) connect youth to adults to serve as mentors and role models, and (c) reduce the achievement gap by socioeconomic status (NRC, 2015). While the research is not robust enough to determine which programs work best for different types of students, the field of informal science learning research looks promising. The committee recommended programs that produce positive outcomes for learners are engaging, responsive, and make student connections (NRC, 2015). As a result of the recommendation of the Committee on Successful Out of School STEM Learning, the current study will examine the relationship of access to STEM activities in a district and SWD performance on the 2015 8th Grade Florida Science Assessment.

Extracurricular Activities

Children in the middle school years, ages 12-14, are at a crossroad in terms of what they do during their time out of school (Adachi-Mejia, Chambers, Li, & Sargent, 2014). There is a variation in activities offered due to an increase in specialization and/or interest in specific types of extracurricular activities. Examples of middle school activities include sports, music, clubs, and/or religious activities (Adachi-Mejia et al., 2014). Extracurricular activities with a focus in science have become more popular due to an increase in young people's exposure and play an important role in influencing the trajectory of science learning for adolescents (Adams, Gupta, & Cotumaccio, 2014; Bell, Lewenstein, Shouse, & Feder, 2009).

Structured extracurricular activities as explained by Balyer and Gunduz (2012) included excursions, competitions, physical education, scouting, music, folklore, education/journal preparation, shows, theatre, fashion shows, exhibitions, chess, tennis, basketball, fair and creative drama. These activities are delivered inside or outside of school as a strategic tool to diminish negative behaviors. Extracurricular activities have a positive impact on student development and contribute to formal learning programs (Fredericks & Eccles 2006). Researchers revealed extracurricular activities have impacts on grades, exam results, and responsibility toward school, culture, socialization, motivation, positive attitudes toward school and educational eagerness (Darling, Caldwell, & Smith, 2008; Llyeras, 2008; Luthar, Shoum, & Brown, 2006; Fujita 2006). Additionally, researchers showed students developed and learned skills they enjoyed (Fredericks & Eccles, 2006; Shulruf, Tumen, & Tolley, 2008).

In 2012, Purcell, Elias, and Atfield published a longitudinal study of entrants to higher education and found participation in extracurricular activities led to less unemployment and more graduate level jobs. Furthermore, the Council for Exceptional Children (CEC; 2001) reported SWD developed skills and self-confidence when they participated in after-school programs that offer a variety of experiences. These social and emotional skills are more difficult to achieve in the typical classroom setting (Snellman et al., 2015). Students with disabilities develop social competence by experiencing friendships and gaining valuable teamwork skills. These experiences are needed for many post high school jobs, especially in the areas of STEM. Unfortunately, there is a paucity of research on extracurricular participation by SWD.

Extracurricular Participation and the Law

As stated in Chapter 1, the Office for Civil Rights (2013) issued guidance on school districts' legal obligation to provide equal access to extracurricular athletic activities to SWD. Furthermore, Section 504 of the Rehabilitation Act stated SWD have an equal opportunity to participate in extracurricular activities. Nonetheless, the U. S. Government Accountability Office (Galanter, 2013) found many SWD were not given an equal opportunity to participate in extracurricular athletics. Furthermore, IDEA (2006) Section 300.107(b) provides a nonexhaustive list of examples of extracurricular and nonacademic activities which expressly includes athletics, clubs, and activities offered by groups sponsored by the school district. In spite of the law, there is limited evidence of the current state of the field regarding student participation in STEM clubs.

Significance of the State of Florida

Klowden and colleagues (2014) reported global competition in technology and science is crucial, considering the increased reliance on innovation. Furthermore, states that invest in innovation and education are emerging stronger from the recession (Klowden et al., 2014). If Florida is to continue to grow and prosper, students must be prepared for the economy they will inherit.

According to the U.S. Census Bureau (2012), there were almost 20 million residents in the state of Florida making it the third most populous state in the nation. In 2014, the Florida Chamber of Commerce reported over 280,000 job postings in Florida with 20% being STEM related. The Florida Department of Economic Opportunity committee (2014) noted the top 135 STEM jobs typically pay double ($22.52) that of the typical Florida wage.

The Florida Department of Economic Opportunity (2014) noted over the past two years there have been between 50,000 to 60,000 STEM related job postings online each month in the state. The authors of the report indicated the following careers are in highest demand (a) healthcare practitioners, (b) technicians, (c) computer scientists, (d) mathematicians, (e) architecture and engineering experts, and (f) business and financial operations. Consequently, there is a need for more STEM employees in the state of Florida.

The Florida Ranking on the Milken State Technology and Science Index is 37^{th} (Klowden et al., 2014). The State of Technology and Science Index provides a benchmark for states to assess their STEM capabilities. Indicators in the ranking include (a) research and development, (b) risk capital and entrepreneurial infrastructure, (c) human capital investment, (d) technology and science workforce, and (e) technology concentration and dynamism (Klowden et al., 2014). Given the fact that Florida has the third largest population in the nations and there is a demonstrated need for a more diverse STEM workforce, the researcher focused on SWD in Florida in the current study. In the following section, the researcher will give an overview of science performance of students with and without disabilities in Florida.

On the 2011 National Assessment of Educational Progress (NAEP) in 8^{th} Grade science in Florida, there was a significant difference on the scaled scores of students with disabilities ($M = 125$, $SD = 37$) and students without disabilities ($M = 152$, $SD = 33$); $p = 0.00$. On the 2009 National Assessment of Educational Progress (NAEP) in 8^{th} grade science in Florida, there was a significant difference on the scaled scores of students with disabilities ($M = 122$, $SD = 34$) and students without disabilities ($M = 149$, $SD = 33$); $p = 0.00$. See Figure 5 for an overview of the NAEP science scores for the state of Florida.

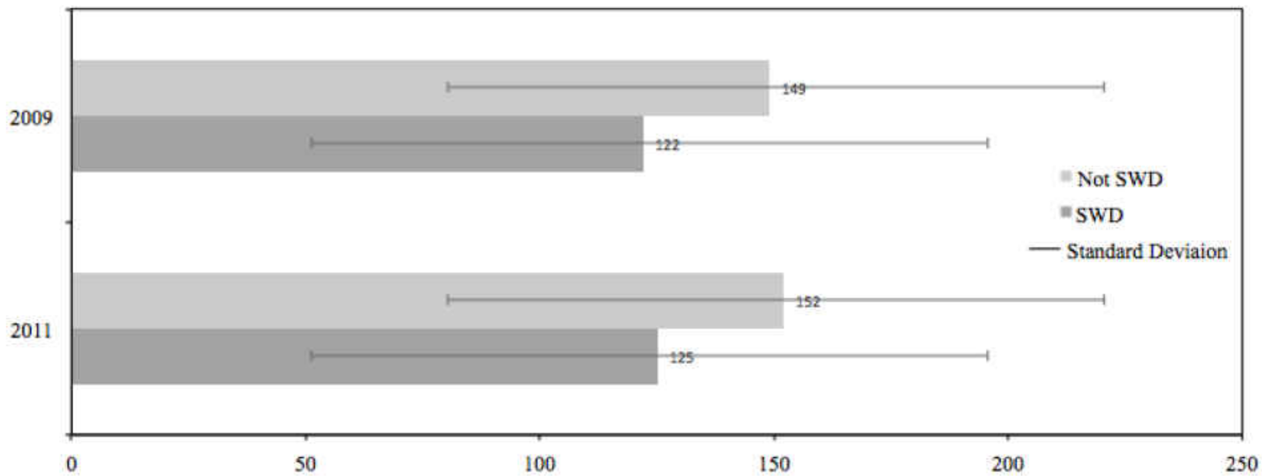

Figure 5. Average Scale Scores for Science, Grade 8 in Florida

Similar to NAEP, students with disabilities who took the Florida Comprehensive Assessment Test (FCAT) in science scored significantly below their peers. Table 3 is an overview of FCAT science scores for 8th grade.

Table 3. 8th Grade FCAT Science Mean Scores

Grade Level 8	Science			
	2012	2013	2014	2015
Not SWD	322	202	203	203
SWD	184	183	184	184

In conclusion, similar to national scores in science, Florida NAEP and FCAT scores suggest SWD have historically struggled in science. As a result, the researcher will examine whether a statistically significant difference exists between SWD and their peers on the 2015 Florida Science assessment for the 8th grade.

Chapter Summary of Literature Review

Schools that increase secondary STEM participation of SWD can impact their employment rates in STEM fields. The strength of the U.S. public education system and the quality of STEM instruction are critical to the success of SWD completing STEM degrees with employment ready knowledge and skills (Leddy, 2010). College persistence for SWD is based on (a) financial support; (b) STEM cooperative learning experiences; (c) STEM research lab placements; (d) off-campus STEM externships; (e) mentoring; and (f) participation in STEM clubs, activities, and learning communities (Leddy, 2010). The researcher's hypothesis is that access to STEM clubs and activities by SWD in the K-12 population will increase their standardized science scores.

According to the NAEP and FCAT, SWD score below their peers in science. There are many reasons SWD struggle including a weakness in reading and problem solving abilities in inquiry based classes (Marino, 2010). Researchers have shown students who participate in extracurricular activities have better outcomes than students who do not participate (Durlak, Weissberg, & Pachan, 2010). Legislators have passed laws requiring schools to include SWD in extracurricular activities (Office for Civil Rights, 2013). However, as stated in Chapter 1, SWD are underrepresented in extracurricular activities and struggle with middle school science (Brigman, Webb, & Campbell, 2007; U. S. Government Accountability Office, 2013). More research is needed in the area of science, extracurricular activities, and SWD (Shields, et al., 2014). As a result, the researcher will examine the relationship of the number of STEM programs offered in a district and the performance of SWD on the 2015 8th Grade Florida Science Assessment. The following questions will guide the research:

RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science assessment?

RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities?

RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

CHAPTER THREE: METHODOLOGY

Introduction

In this chapter, the researcher provides an overview of a study that examined the difference between students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the percentage and type of students with disabilities school personnel report as participating in STEM activities, and the relationship between the number of STEM activities in a district and students with disabilities achievement on the 8th Grade Florida Science Assessment. The researcher began the chapter by providing the theoretical framework that guided the study. Next, the researcher provided the questions that framed the research. Lastly, the researcher described the design and methodology including participants, instrumentation, procedures, and analysis.

Students with Disabilities Struggle in Science

There is a sustained, statistically significant achievement gap between SWD and their non-disabled peers in science. Even after the passage of laws to provide access to the general curriculum through Least Restrictive Environment (LRE) and inclusion mandates, SWD continue to perform significantly lower than their peers on standardized measures of science achievement (US DOE, 2016). The lower performance on 8th Grade science assessments is detrimental to the pursuit of STEM careers because career identity is typically determined at the middle school level (Kesidou & Roseman, 2002).

Students in the U.S. lag behind their international peers in scientific understanding and science education (Sadler & Zeidler, 2009). Concurrently, there is a need to increase students' participation in the STEM workforce (National Research Council, 2010). Many SWD have interests in STEM (Basham & Marino, 2013), however, only 5% enter the STEM workforce (Leddy, 2010). There is a need for students to have an understanding of STEM and the diverse range of related careers. Since middle school students are at an age where decisions will be made that affect their participation in future science endeavors, the focus of the current research study was to determine if the amount of STEM extracurricular activities offered by district correlated with higher 8th Grade standardized science scores of students with disabilities.

Participation in extracurricular activities has been shown to increase skills and self-confidence in SWD (CEC, 2001). Extracurricular activities have been associated with improved academic performance, school engagement, and educational aspirations (Durlak, Weissberg, & Pacan, 2010; Fredricks & Eccles, 2008). The Office for Civil Rights (2013) issued guidance that school districts are legally obligated to provide SWD equal access to extracurricular activities. Unfortunately, there is a lack of research examining the relationship between the number of STEM activities offered in a district and SWD achievement on Science Assessments. The current study addressed this deficit in the literature through an analysis of the achievement gap between students with and without disabilities on the 2015 8th Grade Florida Science Assessment. The researcher examined the number and type of SWD who participated in STEM activities in

Florida districts. In addition, the researcher examined the relationship between SWD achievement in science and the number of STEM activities offered in Florida districts.

Theoretical Support for Study

In Chapter 2, the researcher conducted a review of the literature to determine the learning theories associated with science education for middle school students through extracurricular activities. The researcher determined the learning approaches followed the ideas of constructivism. Constructivism, as defined by Piaget and Garcia (1991), stated people construct their knowledge based on experience gained from the real world.

While the focus of this study was an extracurricular science learning experience, this is not the typical setting in which most students learn science. The typical setting is the science classroom. The primary reason for selecting extracurricular science learning activities was to question whether knowledge constructed from real world, after-school activities will provide insight into student outcomes on high stakes science examinations. Specifically, since extracurricular activities focus on social processes and interactions, the researcher framed the current study on social constructivism.

Purpose

Participation in extracurricular activities positively impacts students' academic performance (Durlak, Weissberg, & Pacan, 2010; Fredricks & Eccles, 2008) but little is known about the number of STEM extracurricular activities a district offers and SWD academic performance in science. Specifically, does the number of activities district and school personnel reported on the survey correlate with SWD science performance. As a result, the researcher examined the differences between students with and without disabilities on the 2015 8th Grade Florida Science assessment, the types and number of STEM activities offered in a district, and the percentage of SWD who participated in informal STEM activities. Additionally, the researcher examined the disability category of SWD who participated in STEM activities. Lastly, the researcher examined the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Science Assessment.

Pilot Study

To validate the current study, the researcher conducted a pilot study on STEM Implementation and Challenges in Central Florida K-12 Schools (see Marino, Fisher, & Gallegos, 2014). The survey and interviews addressed a need to establish a baseline related to STEM implementation, outcomes, and challenges. Participants (N = 237) included 13 district level administrators, 118 principals, 103 assistant principals, and 13 teachers. A survey was administered and semi-structured interviews were conducted. The results of the pilot study indicated STEM programs varied widely across the Central Florida districts. The most widely noted challenge in Central Florida to administer K-12 STEM programs was the lack of federal state funding to provide necessary technologies. The researcher used feedback and results from participants and experts in the field to guide the current study. Following the pilot, the researcher conducted a follow-up survey on the number and types of STEM programs offered throughout the state of Florida.

Research Questions

The researcher in the current study focused on the four survey questions involving SWD, Florida Science Assessments, and participation rates of SWD in extracurricular science activities.

RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment?

- Independent Variables: Disability status
- Dependent Variable: 8^{th} Grade Florida Science Assessment Scores
- Hypothesis: There is a statistically significant difference between the performance of students with and without disabilities on the 2015 8^{th} Grade Florida Science Assessment.

RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities?

- Independent Variable: SWD participation in after-school STEM activities.
- Dependent Variable: Percentage of SWD schools report participating.
- Hypothesis: School personnel will report a small percentage of SWD participating in after-school STEM activities.

RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

- Independent Variable: SWD disability category
- Dependent Variable: Reported level of participation during after-school STEM activities.
- Hypothesis: School personnel will report students with LD as having the highest level of participation in after-school STEM activities.

RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

- Independent Variable: Number of STEM activities
- Dependent Variable: Achievement on Science Assessment
- Hypothesis: There will be a small correlation between the number of STEM activities offered and SWD achievement on the 2015 8th Grade Science assessment.

<u>Methodology</u>

Research Design

The researcher used a convenience sample with single survey administration in this study, in which data from the Florida 8th Grade Science Assessment results were correlated with a survey answered by STEM educators. The purpose of the study was to examine the differences between students with and without disabilities on the 2015 8th Grade Florida Science assessment, the types of STEM activities offered in a district, and the percentage and category of SWD who participate in STEM activities. Lastly, the researcher examined the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Science Assessment.

Procedures

Upon receiving Institutional Review Board approval from the University (see Appendices A and B), the researcher contacted the STEM director for the State of Florida. The STEM director agreed to participate and assisted with the development of the survey questions (see Appendix F). Once the questionnaire was agreed upon by the researcher and the STEM director, the STEM director sent the questionnaire link to each district Science director with instructions to forward it to STEM personnel. Figure 6 is an example of the procedures used for the current study.

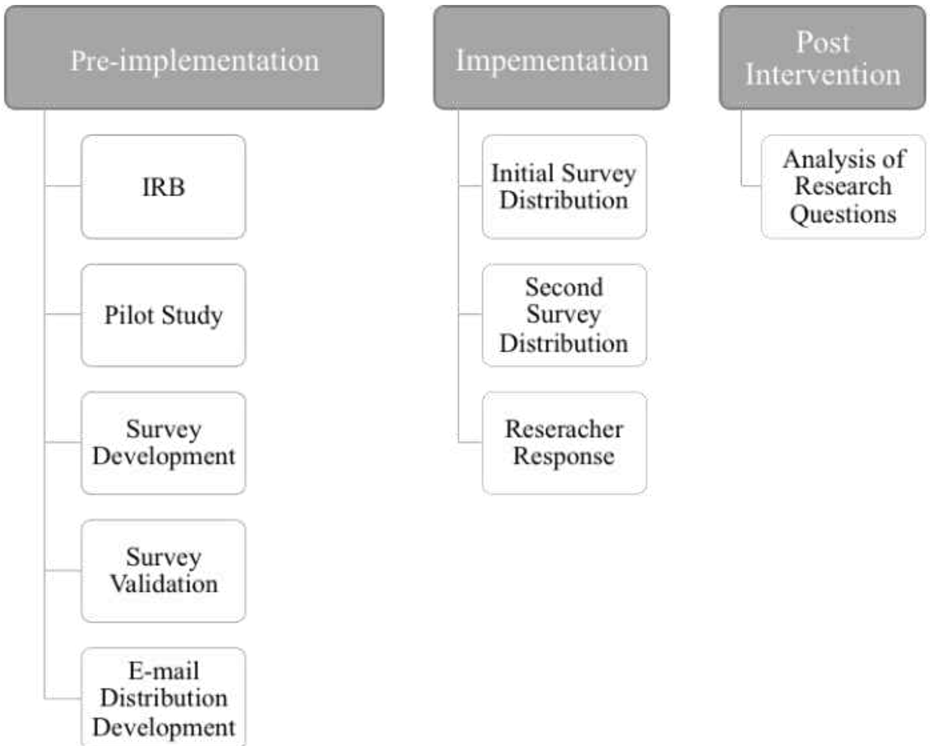

Figure 6. Flow Chart of Procedures

Participants

Population and Sample

RQ1: Is There A Statistically Significant Difference Between the Performance of Students with and Without Disabilities on the 2015 8th Grade Florida Science Assessment?

The population was drawn from all 8th Grade students who took the 2015 8th Grade Florida Science Assessment as reported by the FLDOE. See Table 4 for demographic data of students who took the 2015 Florida Science Assessment. The sample for RQ1 was comprised of the entire population of students who took the 8th Grade Florida Science Assessment. Total students with disabilities do not include students on section 504 plans.

Table 4. Florida 8th Grade Demographics from 76 school districts.

Student Classification	Number
White, non-Hispanic	80,645
Black or African American, Non-Hispanic	43,204
Hispanic/Latino	60,022
Other (i.e., Asian, American Indian, Multi-racial, etc.).	12,773
Female	96,403
Male	100,009
Total Students with Disabilities	21,545
Total Students	196,644

Note. Adapted from the Florida Department of Education (2015)

RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities

RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

The survey population for RQ2, RQ3, and RQ4 was state and district STEM personnel ($N = 489$) from each of the 76 Florida school districts. It is not known how many school and district personnel received the survey because there were instructions to forward to the survey to STEM educators in each district. As a result, a return rate was not calculated. While each district science director ($n = 76$) received the survey e-mail, only 43 districts were represented resulting in a 57%

participation rate by district. Table 5 is an overview of the number of respondents to the survey and the districts they represent. Figure 7 is a flowchart of the respondents who answered the survey.

Table 5. Overview of Survey Respondents

	Respondents	Percentage of those who began survey	Districts	Percentage of all 76 districts
Began Survey	489	100%	Unknown	Unknown
Agreed to take Survey	388	79%	46	61%
Answered district question	413	84%	46	61%
Answered RQ2	230	47%	35	46%
Answered RQ3	75	15%	22	29%
Answered RQ4	239	49%	39	51%

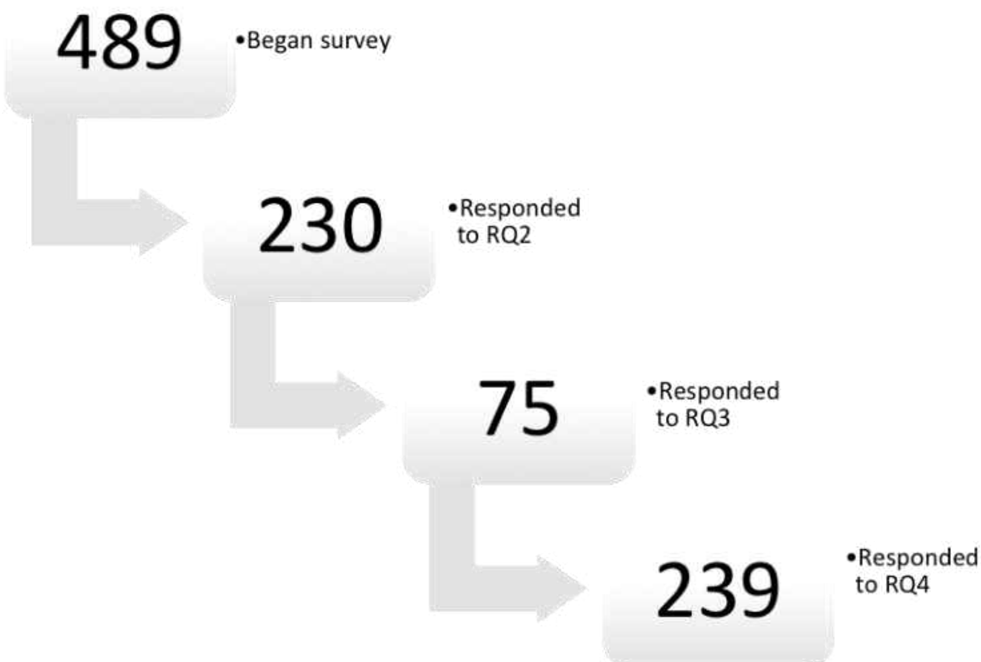

Figure 7. Flowchart of Survey Respondents

Purposive sampling was used in the study. Purposive sampling provides proper selection techniques when a particular group of people have an attribute or trait needed in the study (Nardi, 2003). The trait for this study was public school personnel in Florida who work in the area of STEM education. The survey population was recruited by the STEM director for the FLDOE, who e-mailed district science directors on behalf of the researcher. Coverage error was addressed by utilizing the preexisting relationship between the state STEM director and the district science directors. The FLDOE STEM director sent the survey to district science personnel instead of the researcher. Research organizations are required by the Council of American Survey Research Organizations (2007) to verify that individuals contacted for research by e-mail have a reasonable expectation they will receive the e-mail. A preexisting relationship is necessary for respondents to have such a reasonable expectation (Dillman et al., 2014). The science directors, then forwarded the survey to science teachers and administrators in their respective districts. The first attempt was sent on October 6, 2015. Responses from 124 district personnel from 23 districts were recorded. A second e-mail reminder was sent on October 13, 2015 by the FLDOE STEM director. Sending multiple contacts to potential web survey respondents is the most effective way to increase response rates (Dillman et al., 2014).

The questionnaire was designed without advanced graphics, color, animation, or sound to produce higher response rates (Dillman, Tortora, Conradt, & Bowker, 1998). No incentives were offered to complete the survey. The e-mail sent to the respondents is located in Appendix E, Figure 17. The e-mail was developed using the e-mail contact strategies advocated by Dillman and colleagues (2014). Lastly, the researcher implemented a system for monitoring the Qualtrics survey progress and evaluating early completes as well as responding to questions in a timely manner.

Personnel from 43 districts responded, making up the sample of the study. Additional follow-ups were not warranted because the STEM director did not want to irritate sample members (Dillman et al., 2014). See Table 5 for an overview of the respondents and their positions within their respective districts. As a result of accepting all district personnel information without randomization, the researcher used convenience sampling techniques. For information on the respondents to the online questionnaire, see Tables 5 – 7.

Table 5. Position stated by study participants

Position	Response	Percentage
STEM Teacher	124	47%
Non-STEM Teacher (e.g., special educator, gifted)	46	17%
District STEM Administrator	24	9%
Instructional Coach	7	3%
Specialists	7	3%
School STEM Administrator	5	2%
Other (did not state position)	50	19%
Total	263	

Using skip logic within Qualtrics, teachers were asked what grade level they teach. See Table 6 for an overview of the grade levels taught by respondents who were teachers.

Table 6. Grade Level Taught (if teacher)

Grade level taught	Response	Percentage
K-5	40	37%
6-8	23	21%
9-12	40	37%
Other	4	4%
Totals	107	

When STEM teachers were asked which subject they primarily taught, 79% stated science as noted in Table 7.

Table 7. Primary STEM Subject Taught

Subject	Response	Percentage
Science	53	79%
Technology	8	12%
Engineering	12	18%
Math	8	12%
Other	7	10%
Total	88	

Sample for RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities

The sample size used in RQ2 was determined using the premises advocated by Dillman and colleagues (2014). The sample assumed maximum heterogeneity and used an 80/20 split (i.e., five response choices with a 20% likelihood of choosing each) on a proportion of the population from which the sample was drawn. The population (*N* = 489) is the number of individuals who initially responded to the request to participate in the electronic questionnaire. The margin of error or confidence interval (*B*) was set at +- 0.10 or +-10%. The confidence interval was set at 90% and the margin of error for each tail was set at 0.05. According to Priest (2010), a 90% confidence interval is appropriate for small-scale exploratory research. To compute probabilities, a normal distribution with a mean of zero and a standard deviation of one will need to be calculated (Field, 2013). The resulting scores are denoted by the letter *z* and are known as *z*-scores. A table of probability values have been calculated for the standard normal distribution and provided by Field (2013). The correlating *z* score (*C*) or limits of the confidence interval for the 90% confidence level is 1.645 according to Field's table. In other words, 90% of *z* scores (standardized mean of zero) in a normal distribution will fall between 1.645 and – 1.645. The proportion of the population expected to choose one of the five response categories is .20. Thus, for a question with an 80/20 split in a population of 489 responses, a completed sample size of 61 responses was needed to be sure the estimate of interest will be within +- 10 percentage points 90% of the time. The survey question generated 230 responses, therefore the minimum sample size (*n* = 61) for analysis was met. The 230 responses represented 35 of the 76 school districts as shown in Table 5. As shown in Table 8, there were 112,032 students in the 35 districts which represents 57% of all students and 66% of SWD in Florida public schools.

Sample for RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

The sample size used in RQ3 was determined using the same technique as RQ2. The population (*N* = 489) is the number of individuals who initially responded to the request to participate in the electronic questionnaire. The margin of error or confidence interval (*B*) was set at + 0.10 or -10%. The confidence level was set at 90% and half the margin of error was set at 0.05, or 1-0.90/2 for a two-tailed distribution. The correlating *z* score (*C*) for the 90% confidence level is 1.645. The proportion of the population expected to choose one of the four response categories is .25 (LD, ASD, OHI [e.g. ADHD], and Other). Thus, for a question with a 75/25 split in a population of 489 responses, a completed sample size of 43 responses was needed to be sure the estimate of interest will be within +- 10 percentage points 90% of the time. To explain further, the sample would need to be at least 43 to be sure the middle 90% of *z* or standardized scores fall between the critical value of 1.645 and – 1.645 for a standard normal distribution.

The survey question generated 75 responses, therefore the minimum sample size (*n* = 43) for analysis was met. In conclusion, 75 responses are adequate to generate a standardized normal distribution curve to calculate responses that fall within the 90% confidence interval on both tails of the curve. The middle 90% of the responses for RQ3 should fall within the larger portion of the converted distribution curve.

Population for RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

The population for was drawn from all 8th grade students who took the 8th Grade Florida Science Assessment and the 489 school district personnel who responded to the electronic questionnaire.

Sample for RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

The sample size for RQ4 was determined using the same statistical technique as RQ2. The sample assumes maximum heterogeneity and used an 89/11 split as a proportion in the population from which the sample was drawn. The population (N = 489) is the number of individuals who initially responded to the request to participate in the electronic questionnaire. The margin of error or confidence interval (B) was set at +- 0.10 or +-10%. The confidence level was set at 90% and the margin of error for each tail was set at 0.05. The correlating z score or critical value (*C*) for the 90% confidence level is 1.645. The proportion of the population expected to choose one of the response categories is .11, calculated by dividing 100% by nine response choices (Science Fair, FIRST Robotics, Common STEM planning time, Thematic STEM assignments, Modeling and Simulation Club, SECME, Science Olympiad, Other, and Other). Thus, for a question with an 89/11 split in a population of 489 responses, a completed sample size of 23 responses was needed to be sure the estimate of interest will be within +- 10 percentage points 90% of the time. The survey question generated 239 responses, therefore the minimum sample size (n = 23) for analysis was met. As a result, the researcher is confident 90% of the responses will fall between the critical value of 1.645 and -1.645 for a standard normal distribution of converted z scores.

The 239 responses represented personnel from 36 districts. To further clarify the 8th grade student population the researcher used in the current study, the number of SWD (excluding gifted or 504 plans) and total population for those 36 districts are provided in Table 8. The mean percentage of SWD in each of the 36 districts was 13% with a range of 4% (Lafayette) to 19% (Madison).

Table 8. Population of 8th Grade Students by Florida District

District	Total Students	Number of SWD	Percentage of SWD
Alachua	1954	222	11%
Baker	366	38	10%
Bay	1893	230	12%
Bradford	201	37	5%
Brevard	5229	674	8%
Broward	17883	1858	10%
Charlotte	1201	147	12%
Citrus	1105	87	8%
Clay	2754	400	15%
Collier	3364	338	10%
Columbia	637	78	12%
Duval	8439	774	9%
FAU Lab School	242	25	10%
Flagler	992	101	10%
Hardee	430	54	13%
Hillsborough	16201	2121	13%
Holmes	219	18	8%
Lafayette	94	4	4%
Leon	1983	221	11%
Madison	141	27	19%
Manatee	3412	457	13%
Nassau	914	86	9%
Okeechobee	462	71	15%
Orange	14070	1344	10%
Osceola	4280	362	8%
Palm Beach	13295	1703	13%
Pinellas	7254	634	9%
St. Lucie	3017	314	10%
Santa Rosa	2036	170	8%
Sarasota	3233	353	11%
Seminole	4932	558	11%
Suwannee	463	40	9%
Taylor	203	22	11%
Union	152	24	16%

Volusia	4765	662	14%
Washington	233	35	15%
Total	112,032	14,289	13%

Note. Adapted from the Florida Department of Education (2015)

Data Collection and Instrumentation

The researcher obtained data for this study by accessing the FLDOE website. The FLDOE maintains data on all public schools in the state. The author collected data on the website. Much of the data were reported to the FLDOE annually by school district personnel and were related to student performance. The aggregate data collected from school districts are available on the FLDOE website. This study focused on the assessment scores from state mandated achievement testing in science. No individual student data were used for this study.

In addition to school reported data, the researcher administered a Qualtrics Survey (Appendix F) on STEM activities and SWD. The Qualtrics survey was developed as part of a pilot study. The researcher used feedback from prior participants as well as a Delphi process with seven experts in the field of STEM and special education to develop the questions. Based on feedback from previous research on STEM activities and student outcomes, the primary predictor variable and the related representative questionnaire items are summarized in Table 9.

Table 9. Predictor Variable and Representative Questionnaire Items

Predictor Variable	Representative Questionnaire Item
STEM activities are related to higher SWD science scores.	1. What type of activities does your school or district offer to promote STEM (check all that apply)? 2. What percentage of students in your STEM clubs have a disability? 3. What group of students with disabilities has the largest representation in STEM activities in your district?

Content Validity

Content validity is used to measure variables of interest and is representative of the content (Kerlinger, 1986). Content validity is used by researchers to measure the appropriate sampling of the items in a questionnaire and to determine the degree that the instrument covers the content it is supposed to measure (Bush, 1985). Content validity measures the comprehensiveness and representativeness of a scale (Yaghmaie, 2003). The researcher used guidelines from Dillman and colleagues (2014) to measure content validity when developing the survey questions. The guidelines include (a) make sure the question applies to the respondent, (b) make sure the question is technically accurate, (c) ask one question at a time, (d) use simple and familiar words, (e) use specific and concrete words to specify the concepts clearly, (f) use as few words as possible to pose the question, (g) use complete sentences with simple sentence structures, (h) make sure "yes" means yes and "no" means no, and (i) be sure the question specifies the response task. These guidelines were followed and then examined by experts in the field of STEM and special education for construct validity. All experts agreed the questions were relevant to the research questions.

Face Validity

Face validity is a preliminary form of content validity (Smith & Albaum, 2013). During the pilot study in 2013, five district STEM coordinators were asked to inspect the questionnaire to determine whether the items will answer the research questions (Gall, Gall, & Borg, 2007). Each of the five administrators in the pilot study agreed the questions measured the concepts of extracurricular STEM activities and SWD.

Construct Validity

The definition of construct validity is "the degree to which a test measures what it claims, or purports, to be measuring" (Brown, 1996, p. 231). For the purpose of this study, the researcher examined the constructs of SWD and their participation in extracurricular STEM activities. As such, the survey was developed to include items related to each construct. See Table 10 for an overview of the items related to the constructs of SWD and STEM activities. Experts in the field validated the questions to determine if the constructs were addressed in the questions.

Table 10. Questionnaire Items Related to Constructs

Construct	Questionnaire Item
Students with disabilities	• What programs in your school or district are specifically designed to promote the inclusion of SWD in STEM activities? • What group of students with disabilities has the largest representation in STEM activities in your school or district? • What percentage of students in your STEM clubs have a disability?
STEM activities	• What type of activities does your school or district offer to promote STEM (check all that apply)? • What programs in your school or district are specifically designed to promote the inclusion of SWD in STEM activities? • What group of students with disabilities has the largest representation in STEM activities in your school or district? • What percentage of students in your STEM clubs have a disability?

A copy of the electronic survey is located in Appendix F. The first question the researcher evaluated from the survey is: What type of activities does your school or district offer to promote STEM (check all that apply)? Responses on the questionnaire included: (a) science fair, (b) FIRST robotics, (c) Common STEM planning time, (d) Thematic STEM assignments, (e) Modeling and Simulation Club, (f) SECME, (g) Science Olympiad, and (f) Other STEM Club. For Other STEM club, participants wrote in responses.

The next survey question the researcher examined was: What percentage of students in your STEM clubs have a disability? The participant could select one answer: (a) "We do not track the number of students with a disability in our STEM clubs", (b) 0 – 20%, (c) 21 – 40%,

(d) 41 - 60%, or (e) greater than 60%. The last question the researcher examined was: What group of students with disabilities has the largest representation in STEM activities in your school district? The answers were (a) Learning Disability, (b) Autism Spectrum Disorder, (c) Other Health Impairment (e.g. ADHD), or (d) Other. For "Other" participants had the option to write an answer.

Reliability

To determine the reliability of the electronic survey, the researcher analyzed responses to questions used to answer research questions 2 and 3. The five districts selected for reliability analysis expressed the highest response rates: Santa Rosa (n = 112), Palm Beach (n = 54), Seminole (n = 46), Orange (n = 37), and Suwannee (n = 36). The researcher analyzed RQ 2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities? first. Internal consistency for Santa Rosa was 83%, Palm Beach 83%, Seminole 59%, Orange 67%, and Suwannee 76%. The mean internal consistency for the five districts was 74% with a range of 59-83%.

Next the researcher analyzed the internal consistency for RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities? Santa Rosa had an internal consistency rate of 56%, Palm Beach 50%, Seminole 57%, Orange 75%, and Suwannee 100%. The mean internal consistency for the five districts was 68%

with a range of 50-100%. A mean internal consistency rate of 68% is considered questionable (George & Mallery, 2003).

The next instrument used in the study was the 8^{th} Grade Florida Science Assessment. The Statewide Science Assessment measures student achievement of the Next Generation Sunshine State Standards in science (FLDOE, 2016). The assessments are standards-based, summative tests that measure 8^{th} grade students' achievements in science. The assessment results help leadership and stakeholders determine how goals are being met (FLDOE, 2015). Achievement levels were determined in 2012 through a standard-setting process. The tests are constructed to meet rigorous technical criteria (Standards for Educational and Psychological Testing [American Educational Research Association; AERA, American Psychological Association; APA, National Council on Measurement in Education; NCME, 2014]). The results are useful for understanding the degree individual students have mastered the Florida Standards and whether students are improving their performance over time. Test items were selected prior to the test administration to ensure the test construction aligned with the approved blueprint. The content and psychometric verification log was kept to track compliance to the test structure to the Florida State Assessment (FSA) requirements (FLDOE, 2015). While reliability and validity is reported by the FLDOE for the FSA English Language Arts (ELA), Mathematics, and End of Course (EOC) assessments, psychometric properties for the science assessment were not available.

Data Analysis

RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment? For research question 1, the researcher analyzed the data to assess the difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment. The data were analyzed using an independent *t*-test. The *t*-test was selected to test the null hypothesis that no differences exist between the two variables. As such, the researcher compared the differences between the means of two groups, SWD and students without disabilities. The researcher used an independent-samples *t* test because different participants were being measured. A potential problem with using a *t*-test is it is dependent on the standard deviation. Specifically, if the standard deviation is small, then the differences between the sample means can occur by chance. Additionally, the *t*-test is reliant upon parametric assumptions being met. If those assumptions are not met, the *t*-test is not as robust as a non-parametric test like the Mann-Whitney Test (Field, 2013)

RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities? For research questions 2, data on the percentage of SWD school personnel reported as participating in STEM activities and the disability category reported as having the highest level of participation were analyzed with descriptive statistics. Descriptive statistics are used for organizing and summarizing a set of numerical data (Gall et al., 2007). To analyze RQ2, categorical data were collected and summarized by creating frequency distributions. Additionally, the frequency of responses in each category on the survey questions was displayed as a percentage of the total.

RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities? Similar to research question 2, data on the percentage of SWD school personnel reported as participating in STEM activities and the disability category reported as having the highest level of participation were analyzed with descriptive statistics.

RQ4: What is the relationship between the number of STEM activities in a district and SWD's achievement on the 8th Grade Florida Statewide Science Assessment? Correlational research was used to determine the relationship. The purpose of correlational research is to discover relationships (Gall et al., 2007). First, a scatter plot was generated to show a pictorial representation of the correlation between students with disabilities scores on the 8^{th} Grade Florida Science Assessment by district and the number of STEM activities offered by district. The *X* axis on the graph contains the average scores by district and the *Y* axis contains the number of STEM activities by district. A line of best fit was generated to visually represent whether a positive, negative, or absence of a correlation exists in the data.

Next, the researcher calculated a bivariate correlation because the research question is based on the evaluation of two variables, results of SWD on the 8^{th} Grade Florida Science

Assessment by district and the number of STEM activities offered per district. The data collected were first treated as a series of bivariate data sets. A correlation coefficient is a quantitative assessment of the strength of a relationship between the two values in a set of pairs (Devore & Peck, 1997). The purpose of a correlation coefficient is to express in mathematical terms the degree and relationship between two variables (Gall et al., 2007). The Pearson's Correlation Coefficient is one of the most frequently used formulas for assessing the relationship between the values in a set of pairs. The researcher used Pearson's correlation to assess the relationships between the number of STEM activities in a district and SWD achievement on the 8th Grade Florida statewide science assessments. A significance level of 0.05 was used for all analyses.

Summary

The population of Florida 8th grade middle school students were represented by a convenience sample of personnel from 43 districts. Existing data on the FLDOE's website on each district for SWD were accessed by the researcher. After gathering the data on the science scores of students with and without disabilities along with feedback on the questionnaire filled out by district personnel, the researcher analyzed results using descriptive statistics. A series of Pearson's Correlation procedures were utilized in the next chapter to determine if there was a relationship between student science assessment scores and the number of STEM activities offered by a district.

CHAPTER FOUR: RESULTS

Overview

The purpose of this study was to determine if there were differences between students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the types and number of STEM activities offered in school districts in Florida, and the percentage of SWD who participate in STEM activities in each district. Furthermore, the researcher examined the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Science Assessment. The research questions that guided the researcher in this study were:

RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment?

RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities?

RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

In this chapter, the researcher presents the results of the data analyses for each of the research questions. The first research question was an investigation of Florida Science Assessment scores between students with and without disabilities. To determine if there was a statistically significant difference between students with and without disabilities on the 2015 Florida Science Assessment, the researcher performed an independent samples *t*-test to determine whether any mean differences existed between the scores of the two groups.

Research question 2 was posed by the researcher as an investigation of the percentage of SWD school district personnel report as participating in after-school STEM activities. The researcher further delineated the disability category school personnel report as having the highest level of participation during after-school STEM activities for research question 3. To answer these research questions, the researcher used descriptive statistics to determine the mean percentages as reported by survey respondents per district.

In research question four, the researcher examined the relationship between the number of STEM activities in a district and SWD performance on the 2015 8^{th} Grade Science Assessment. To determine the relationship, correlational methodology was used to analyze a scatter plot and then a bivariate correlation to determine the correlation coefficient. The researcher subsequently used a correlation coefficient to determine the degree and relationship between the variables.

Instrumentation

The outcome variable for RQ1 and RQ4 was the 8th Grade Florida Science Assessment taken by public school students. In 2015, 196,521 8th grade students took the assessment. Of those students, 48% achieved a passing score considered level three and above. Passing scores by district ranged from 76% in St. Johns County to 14% in Madison county. Only 19% of students with disabilities scored level three or above (FLDOE, 2015). The researcher created and used a survey to answer RQ2, RQ3, and RQ4. Survey analysis allowed the researcher to determine the number of after-school STEM programs offered in a district and the percentages and type of SWD who participated in the activities. The survey was based on skip logic and consisted of 31 questions related to STEM professional development and activities. See Appendix F for a copy of the electronic questionnaire.

Data Analysis Procedures

Data from the FLDOE were downloaded into a Microsoft Excel spreadsheet and manually entered into an SPSS (Version 20) statistics spreadsheet for all students who took the 8th Grade Florida Science Assessment. The researcher used a total of 196,521 student scores in the study. A total of 35 out of 75 districts were represented in the questionnaire. Lafayette district was dropped from the analyses because administrators did not report their four SWD 8th Grade Florida Science Assessment Scores to the FLDOE. While 530 individuals began the survey, only

230 responded to RQ2. The researcher analyzed 75 responses for RQ3. For RQ4, 239 district representatives responded and all of those responses were used by the researcher in the analysis. The five independent variables were: (a) student disability classification; (b) level at which schools monitor SWD participation in STEM clubs; (c) disability category that participates in after-school STEM clubs; and (d) number of reported STEM activities per district. Sample sizes are reported in Table 11 and 12, below.

Table 11. Sample Sizes of Disaggregated Groups by Research Question

Research Question	Participants
RQ1	196,521 8th Grade Students
RQ2	230 Survey Respondents
RQ3	75 Survey Respondents
RQ4	239 Survey Responses and 21,745 8th Grade SWD

Table 12. Sample Sizes of Disaggregated Groups

Group	Districts	SWD	Students without disabilities
n	35	16,750	134,517

Results

In order to answer RQ1, whereby the researcher examined the differences between the students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the researcher performed an independent samples *t* test.

Assumptions

The dependent variable used in the analysis was the 2015 8th Grade Florida Science Assessment scores and the independent variable was students' disability classification, which are students who have individual education programs and excludes students who are gifted and have 504 plans. The descriptive statistics of the test results are provided by the researcher in Table 13. The researcher calculated scores by district.

Table 13. Descriptive statistics of the 8th Grade Science Assessment results for all students tested.

Mean Scale Score		Statistic	Std. Error
Mean		199.68	.795
95% CI for Mean	Lower Bound	198.10	
	Upper Bound	201.27	
5% Trimmed Mean		200.04	
Median		201	
Variance		46.163	
Std. Deviation		6.794	
Minimum		176	
Maximum		215	
Range		39	
Interquartile Range		7	
Skewness		-1.095	.281
Kurtosis		2.820	.555

Note. CI = confidence interval; std. = standard

With each statistical analysis a set of assumptions, the researcher must satisfy or address prior to running the analysis. For an independent *t* test, the following assumptions must be satisfied: normality, homogeneity of variance, and independence (Lomax & Has-Vaughn, 2012).

Normality for all students

As shown in Table 13, the skewness value is -1.095 (*SE* = 0.281) and the kurtosis value is 2.82 (*SE* = 0.555). Skewness and kurtosis values within the range of +/-2(*SE*) are generally considered normal (Lomax & Has Vaughn, 2012). Applying this rule, normality is evident in skewness but not kurtosis.

A histogram with a normal curve overlay is depicted in Figure 8. Taken with the skewness and kurtosis statistics, these results indicate the mean scores on the 2015 8th Grade Science Assessment were not normally distributed. There is a slight negative skew such that more scores are at the higher end of the distribution than a typical normal distribution. There is a positive kurtosis indicating that the distribution of scores are leptokurtic, with more extreme scores in the middle of the distribution. Again, however, the kurtosis values are not within the range of what is considered a reasonable approximation to the normal curve.

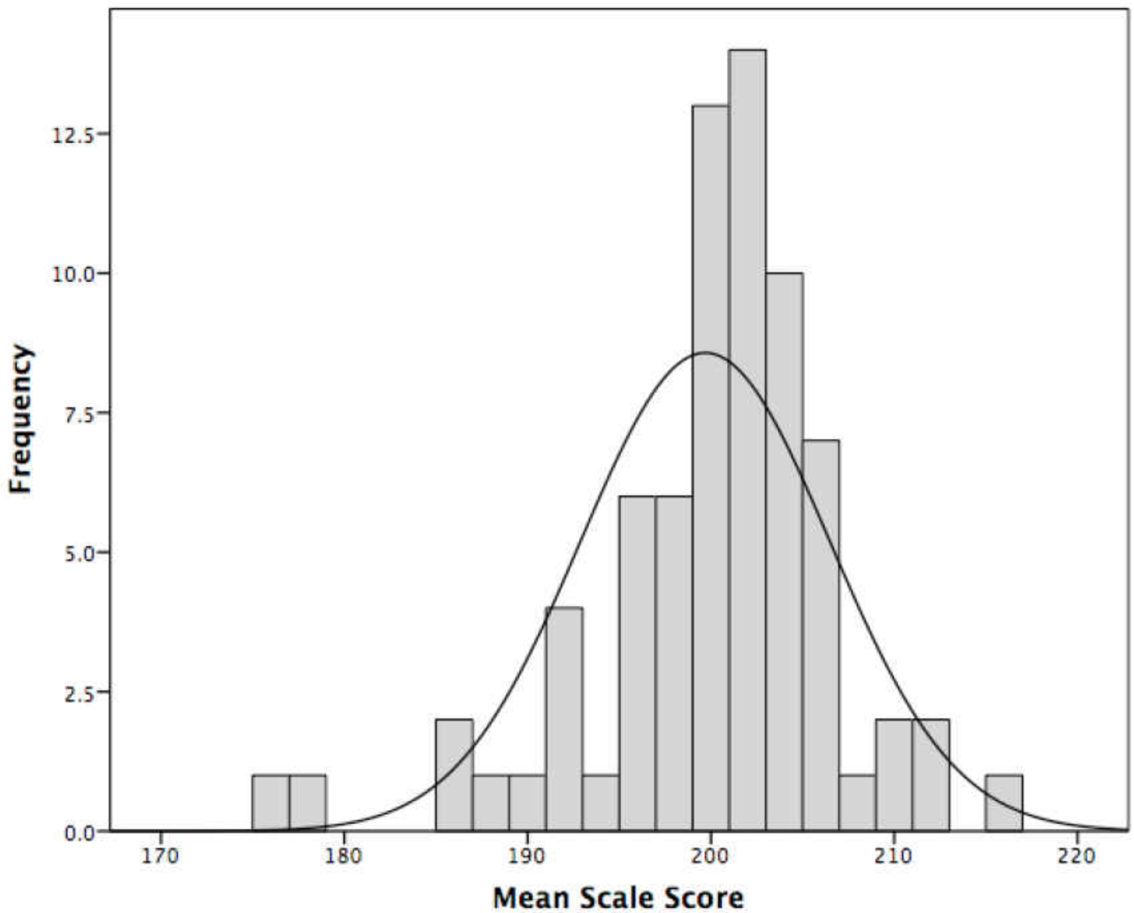

Figure 8. Distributions of 8th Grade science assessment scores for all students tested.

Due to the lack of normality of the data, outliers were examined via a boxplot displayed in Figure 9. The boxplot suggested an abnormal distribution with outliers. The outliers include the districts of St. Johns (m = 214, n = 2699), Hamilton (m = 186, n = 130), Madison, (m = 185, n = 141), Florida School for the Deaf and Blind (FSDB; m = 176, n = 32), and Jefferson (m = 177, n = 48). A Grubb's test (1950) was performed through several iterations until no outliers were found with the same results as shown in the boxplot in Figure 9. The Grubb's test also indicated St. Johns, Hamilton, Madison, FSDB, and Jefferson school districts average 8th grade science scores were outliers. As a result, these outlying scores were removed from the analysis, because they were more than two standard deviations from the mean (Lomax & Hahs-Vaughn, 2012).

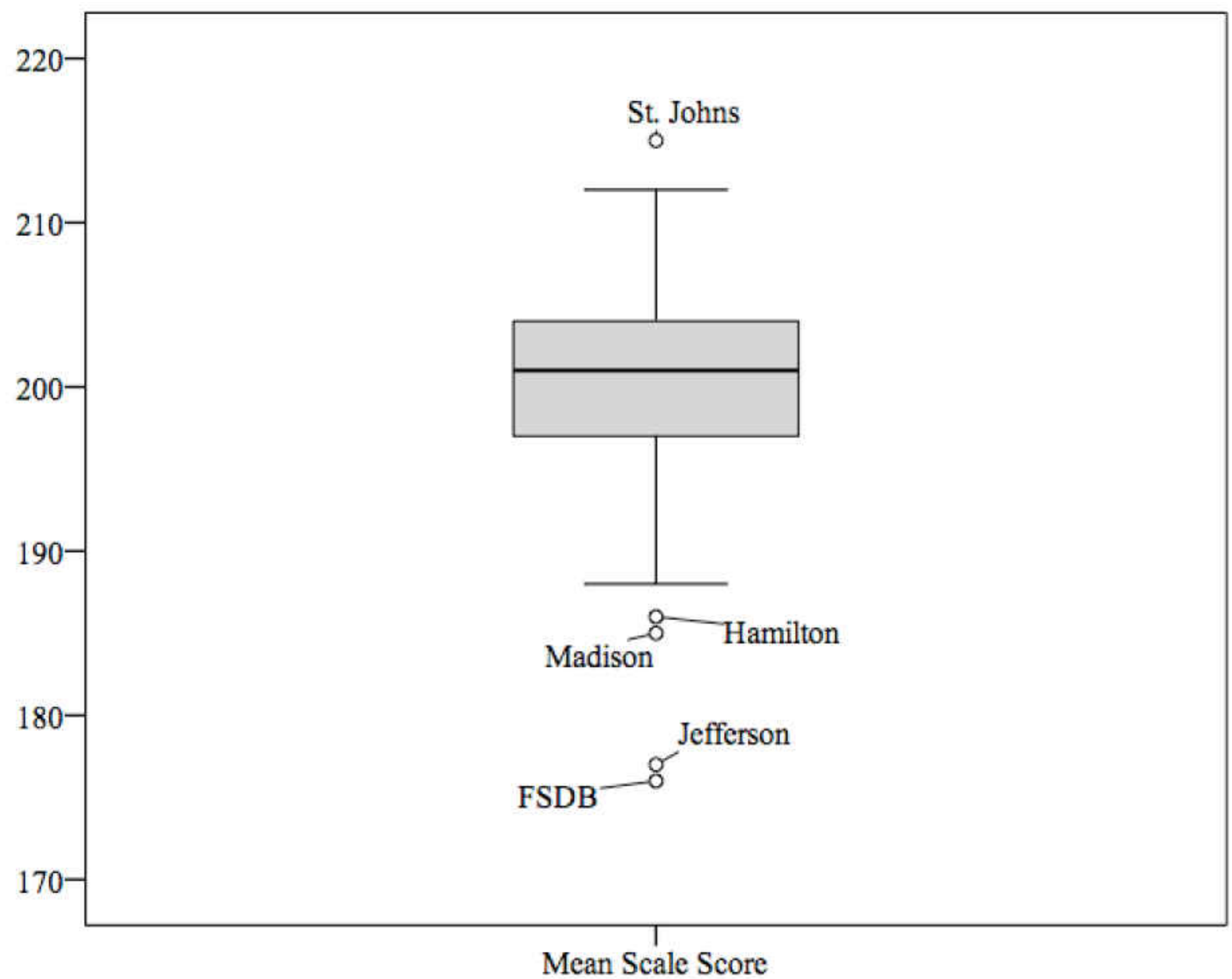

Figure 9. Boxplot of all 8th Grade Students by District who took the 2015 Florida Science Assessment

The revised descriptive statistics are provided by the researcher in Table 14. In the case of both students with and without disabilities the mean score on the Florida Science Assessment was 200.33 without the outlying scores.

Table 14. Revised Descriptive statistics of the 8th Grade Science Assessment results for all students tested.

	N	Range	Min	Max	*M*	*SD*	Variance	Skewness		Kurtoses	
	S	S	S	S	S	S	S	S	*SE*	S	*SE*
MSS	69	27	185	212	200.33	5.14	26.431	-.405	.289	.89	.57

Note. S = statistic, MSS = mean scale score

As shown in Table 14, the skewness value is -0.405 (*SE* = 0.289) and the kurtosis value is 0.89 (*SE* = 0.570). Given the revised values, skewness and kurtosis are within the normal range. A revised histogram with a normal curve overlay is depicted in Figure 10. Taken with the skewness and kurtosis statistics, the revised results indicate that the mean scores on the 2015 8^{th} Grade Science Assessment are normally distributed. A slight negative skew at the higher end of the distribution than a typical normal distribution is noted. There is a slight positive kurtosis indicating that the distribution of scores are slightly leptokurtic, with more extreme scores in the middle of the distribution. Again, however, the values are within the range of what is considered a reasonable approximation to the normal curve.

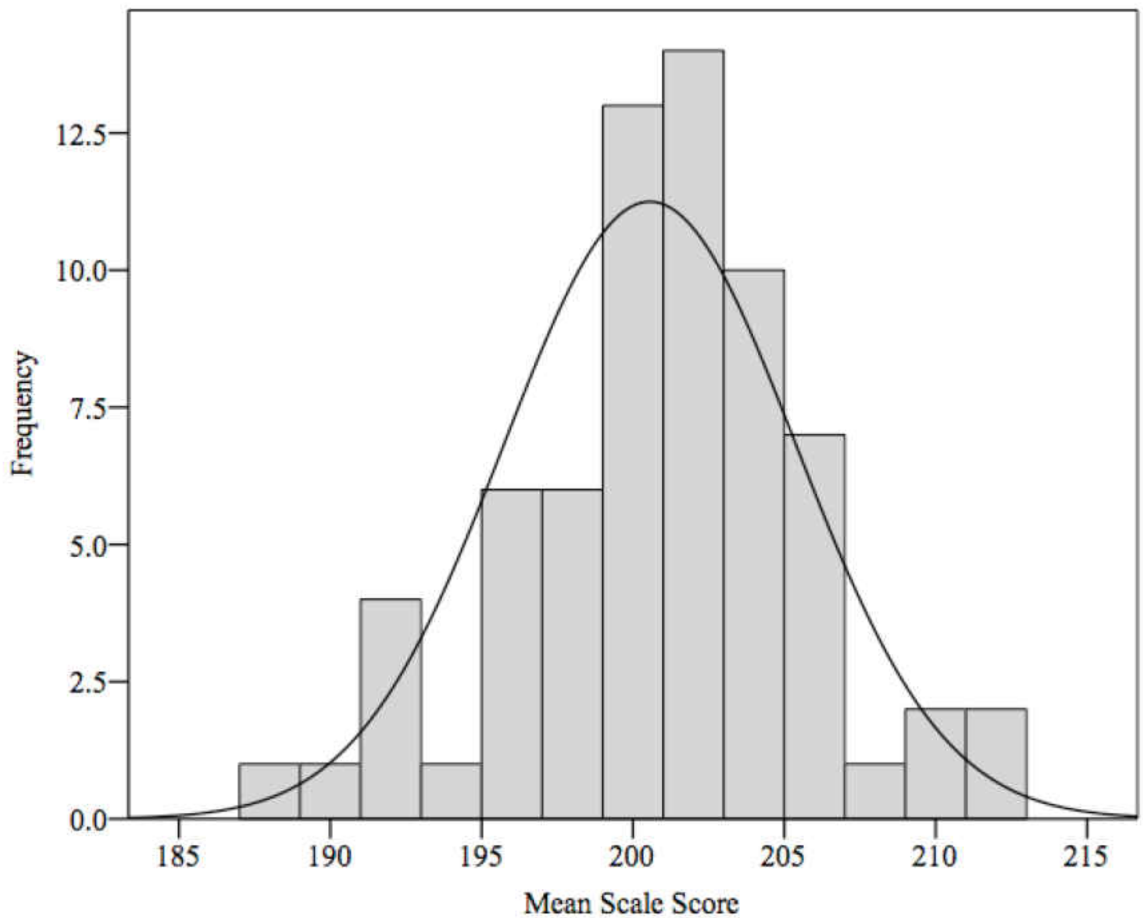

Figure 10. Revised Distributions of 8th Grade Science Assessment scores for all students tested.

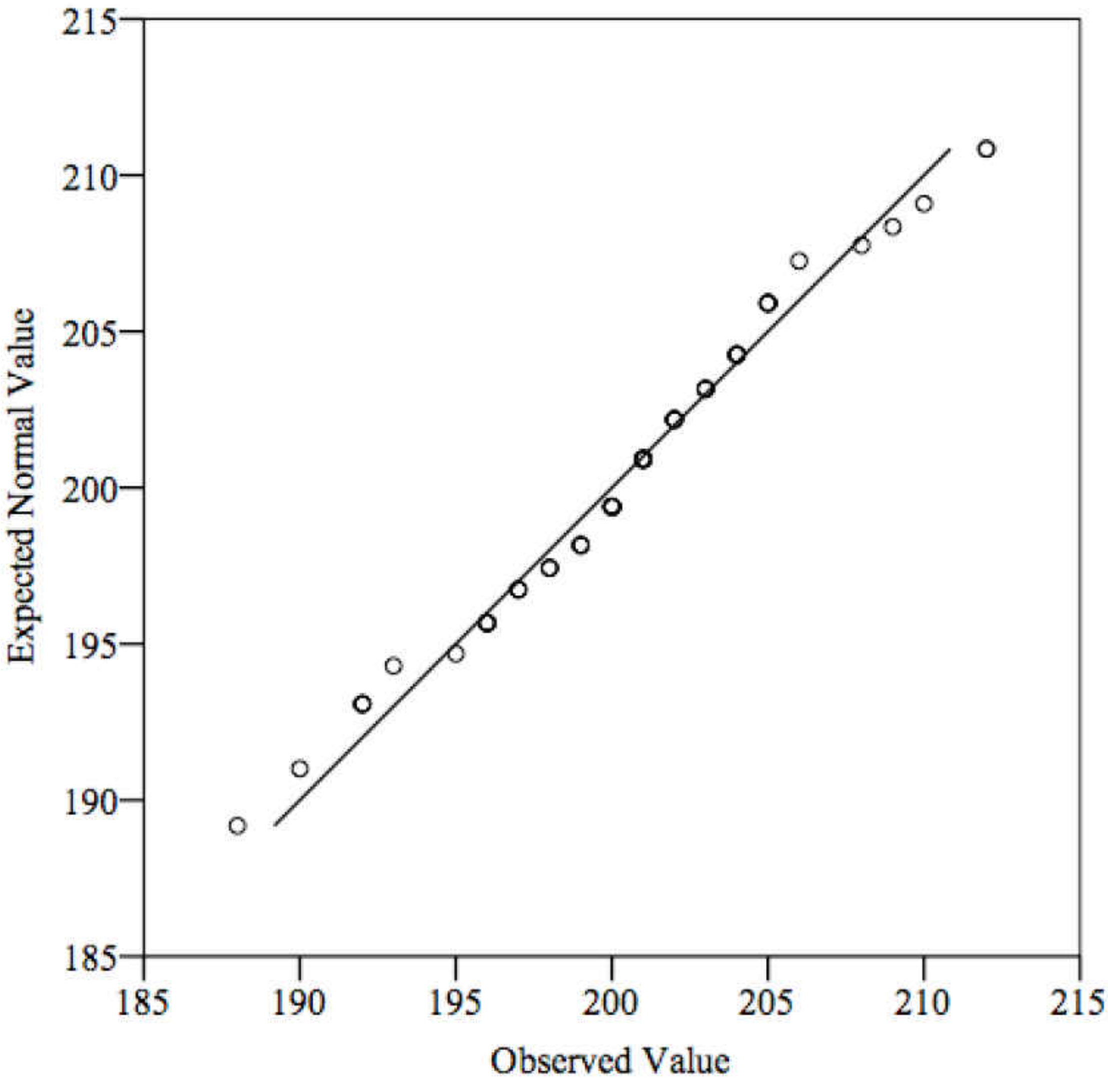

Figure 11. Normal Q-Q Plot of Mean Scale Score

The Q-Q plot in Figure 11 suggested some minor nonnormality for all students. The results are consistent with the prior statistics.

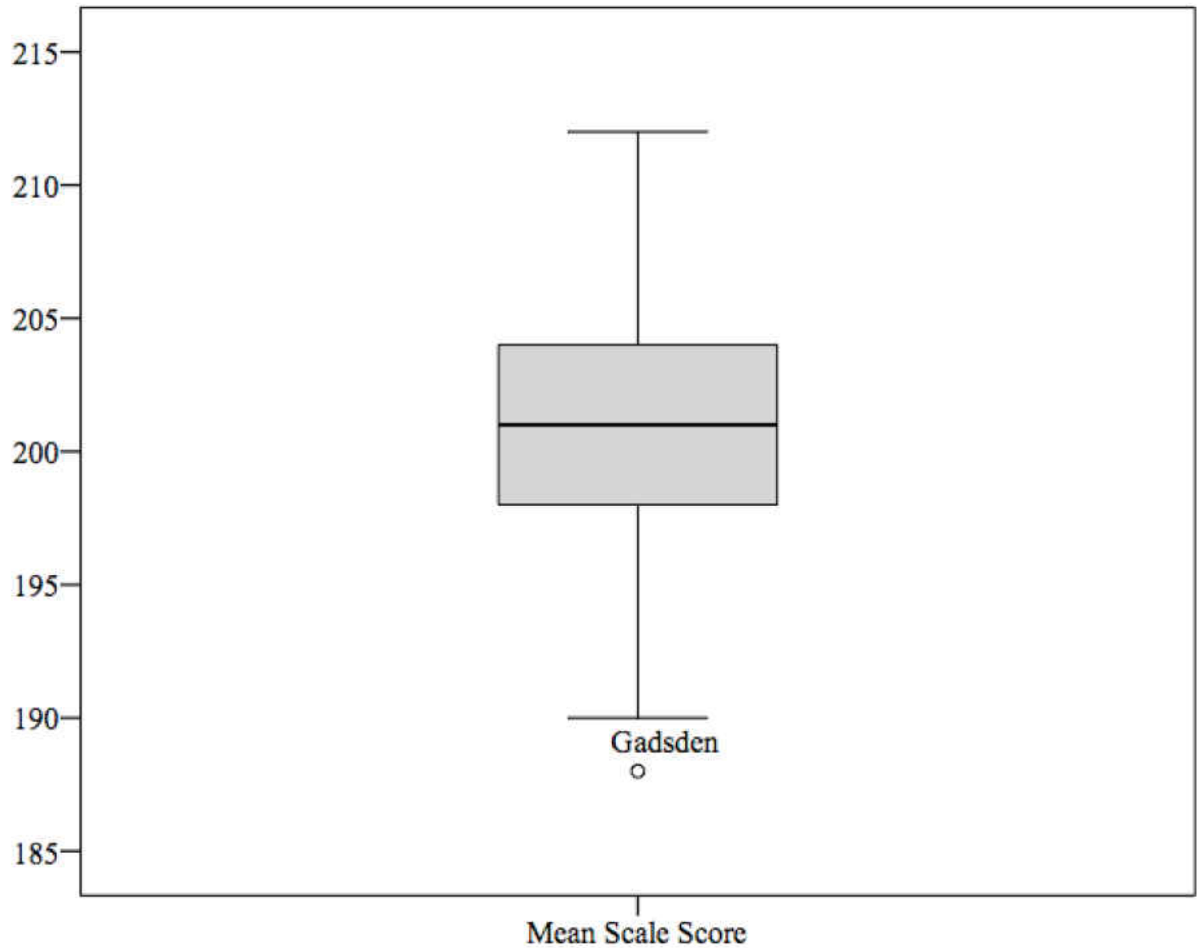

Figure 12. Revised Boxplot

The revised boxplot in Figure 12 suggested a relatively normal distributional shape with one outlier (i.e., Gadsden County). However, according to Grubb's (1950) test, the outlier was furthest from the rest but not a significance outlier ($p > 0.05$). Although normality indices generally suggest the assumption is met, even if there are slight departures from normality, the effects on Type I and Type II errors will be minimal given the use of a two-tailed test (Glass, Peckham, & Sanders, 1972). Type I error is the rejection of the null hypothesis when it is unwarranted (Gall et al., 2007). If the rejection of the null hypothesis is unwarranted it is called a Type I error (Cowles & Davis, 1982). Type II error, on the other hand, is the failure to reject the null hypothesis of no difference, when there is a difference (Gall et al., 2007).

Table 15. Test for normality

	Shapiro-Wilk		
	Statistic	*df*	Sig.
Mean Scale Score	.969	69	.088

A review of the Shapiro-Wilk (S-W) test for normality ($SW = .969$, $df = 69$, $p = .088$) suggested that normality of the 8th Grade Science Assessment for SWD results was a reasonable assumption (Table 15). The descriptive statistics of the 2015 8th Grade Florida Science scores of SWD are provided in Table 16. In the case of students with disabilities the mean score on the Florida Science Assessment was 182.72.

Table 16. Descriptive statistics of the 8th Grade Science Assessment Results for SWD.

Mean ESE Scale Score		Statistic	*SE*
Mean		182.72	.582
95% CI for Mean	Lower Bound	181.56	
	Upper Bound	183.89	
5% Trimmed Mean		182.68	
Median		183	
Variance		22.047	
Std. Deviation		4.695	
Minimum		172	
Maximum		195	
Range		23	
Interquartile Range		6	
Skewness		.052	.297
Kurtosis		.103	.586

Note. CI = confidence interval; ESE = Exceptional Student Education

<u>Normality for students with disabilities</u>

As shown in Table 16, the skewness value is -0.052 (*SE* = 0.297) and the kurtosis value is 0.103 (*SE* = 0.586). Skewness and kurtosis values would be considered normal. A histogram with a normal curve overlay is depicted in Figure 13. Taken with the skewness and kurtosis statistics, the results indicate that the mean scores of SWD on the 2015 8th Grade Science Assessment are normally distributed.

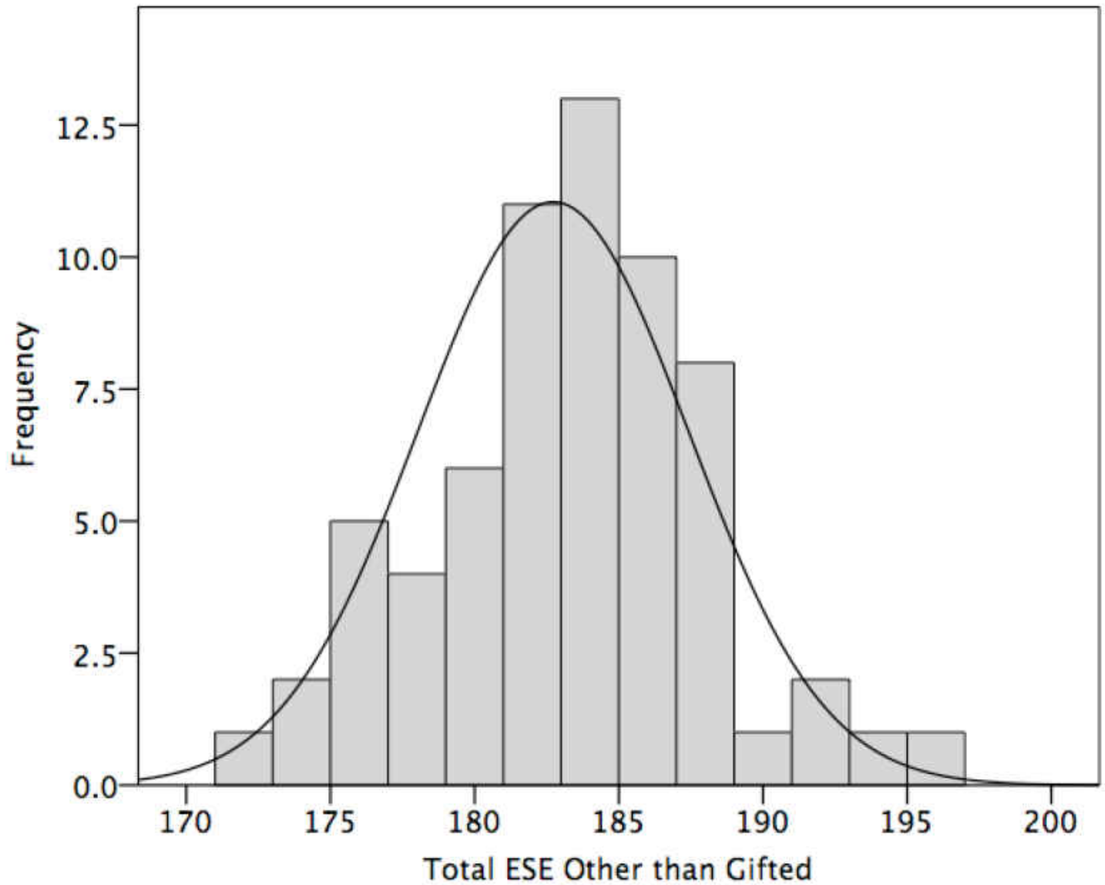

Figure 13. Distributions of 8th Grade Science Assessment scores for SWD.

Table 17. Tests for Normality for SWD

	Shapiro-Wilk		
	Statistic	*df*	Sig.
SWD	.988	65	.771

A review of the Shapiro-Wilk (S-W) test for normality (*SW* = .988, *df* = 65, *p* = .771 suggested that normality of the 8th Grade Science Assessment for SWD results was a reasonable assumption as shown in Table 17.

Homogeneity

One of the assumptions of an independent samples *t* test is that the variances of the two groups are homogeneous. In order to test this assumptions, a Levene's test for equality of variances was performed on the data. As shown in Table 18, Levene's test was satisfied (F = .061, p = 0.805). Since Levene's test was not significant, the assumption of homogeneity of variance was met.

Independence

Because there was no random assignment of the individual districts to students with or without disabilities, the assumption of independence was not met, creating a potential for an increased probability of a Type I or Type II error.

Missing data

The sample the researcher used for the statistical analyses in the current study did not include any cases with missing data from the electronic questionnaire or the Florida 2015 Science Assessment scores. The final sample of participants whose data were analyzed in this study included a total of 239 school personnel from 35 districts and 196,521 students.

Sufficiently large sample size

The *t* test for independent means were assessed by the researcher using two different samples. The first sample included 69 school districts who reported mean 8th Grade Florida Science Assessment scores for all students and 65 school districts who reported mean 8th Grade Florida Science Assessment scores for SWD in 2015. Based on G*power version 3.1.9.2, computer based power analysis software (Faul, Erdfelder, Buchner, & Lang, 2009), the suggested sample size was a total of 52 school districts or 26 districts for each group. Input parameters for G*power were two tails, effect size $d = 0.8$, α error probability = 0.05, Power (1-β error probability) = 0.80, and allocation ratio N2/N1 = 1. The analysis for RQ1 met the suggested sample size.

Table 18. *T*-test for Independent Means

	Levene's Test		*t*-test for Equality of Means						
								95% CI	
	F	Sig.	*t*	*df*	Sig.	MD	SED	L	U
EV	.061	.805	20.665	132	.000	17.61	.852	15.925	19.296

Note. EV = equal variances assumed, Sig. = significance, MD = mean differences, SED = standard error difference, CI = confidence interval of the difference, L = lower, U = upper

Results

Research Question 1

An independent samples *t* test was conducted to determine if the mean difference between students with disabilities differed from all students on the 2015 8th Grade Florida Science Assessment. The assumption of normality was tested and met for the distributional shape of the dependent variable, mean scores on the 8th Grade Science Assessment. As shown in Table 18, mean scores on the 8th Grade Florida Science Assessment were collected from 73 Florida school districts with a mean of 200.33 (*SD* = 5.141) and SWD mean of 182.72 (*SD* = 4.695). The independent samples *t* test indicated that the means were statistically significantly different ($t = 20.665$, $df = 132$, $p = .000$). Thus, the null hypotheses that the scores would be the same by disability or not was rejected at the 0.05 level of significance. The effect size *d* (calculated using the pooled standard deviation) was 0.70. Using Cohen's (1988) guidelines, this is interpreted as a large effect. The results provide evidence to support the conclusion that students with and without disabilities differ on the Florida Science Assessment, on average. More specifically, SWD were observed to score lower, on average, than students without disabilities.

Research Question 2

In order to answer RQ2, whereby the researcher examined the percentage of SWD, school personnel report as participating in after-school STEM activities, the researcher performed descriptive statistics. The results from 230 responses on the electronic STEM questionnaire are displayed by the researcher in Table 19. As noted in Table 4, those 230 respondents represented 46% of the 76 Florida public school districts.

Table 19. The Percentage of SWD School Personnel Report as Participating in STEM Activities

Answer	Response	Percentage
We do not track the number of SWD	173	75
0-20%	47	20
21-40%	5	2
41-60%	4	2
Greater than 60%	1	0
Total	230	

Over 170 respondents, or 75% said their district does not track the number of students with disabilities in their STEM clubs. Twenty percent of the respondents said 0-20% of their students with disabilities participate in an after-school STEM activity.

Research Question 3

Research question 3 was aimed at examining the disability category school personnel report as having the highest level of participation during after-school STEM activities. The researcher used non-parametric descriptive statistics to evaluate the data. As shown in Table 20, the question on the electronic questionnaire was answered by 75 respondents. Of those, 42 respondents or 56% of the school personnel said students with learning disabilities had the highest level of participation during after-school STEM activities. Next was Other Health

Impairment (e.g. ADHD) with 20% of the responses followed by autism spectrum disorder (16%). Six respondents typed in other which included students who are English Language Learners, Gifted, None, Anxiety and Social Phobias, and Physically Handicapped. One respondent wrote “most disabled students attend one particular school in our district”.

Table 20. Disability Category with the Highest Representation in STEM Activities

Answer	Response	Percentage
Specific Learning Disability	42	56
Autism Spectrum Disorder	12	16
Other Health Impaired (e.g. ADHD)	15	20
Other	6	8
Total	75	

Research Question 4 Assumptions

For research question 4, the researcher attempted to determine the relationship between the number of STEM activities in a district and students with disabilities’ achievement on the 8th Grade Florida Statewide Science Assessment. To analyze the relationship, the researcher needed to determine the number of STEM activities in each district. The researcher asked; What type of activities does your school or district offer to promote STEM (check all that apply)? Two hundred and thirty people responded to the question as shown in Table 21.

Table 21. Types of Activities Offered in the Respondent's School or District

Answer	Responses	Percentage of Respondents
Science Fair	188	79
FIRST Robotics	78	33
Common STEM Planning time	48	20
Thematic STEM assignments	57	24
Modeling and Simulation Club	24	10
SECME	80	33
Science Olympiad	69	29
Other	96	40
Total	230	

Additionally, respondents typed in the names of STEM activities not listed in the response. All responses are represented in Appendix H, Table 33. Table 22 is a summary of activities, the number of districts who offer the activity and the name of the districts.

Table 22. Summary of Activities, Number, and Name of Districts that Offer Activity

STEM clubs offered in districts

Type of Activity	Number of Districts	Which Districts
Science Fair	30	Alachua, Bay, Bradford, Brevard, Broward, Charlotte, Citrus, Clay, Collier, Columbia, Hardee, Hillsborough, Holmes, Lafayette, Leon, Madison, Manatee, Dade, Nassau, Okeechobee, Orange, Osceola, Palm Beach, Pinellas, St. Lucie, Santa Rosa, Sarasota, Volusia
FIRST Robotics	28	Alachua, Bay, Brevard, Broward, Clay, Columbia, Flagler, FAU Lab School, Florida Virtual School, Hillsborough, Holmes, Leon, Dade, Nassau, Okeechobee, Orange, Osceola, Palm Beach, Pinellas, St. Lucie, Santa Rosa, Sarasota, Seminole, Suwannee, Taylor, Union, Volusia
Science Olympiad	20	Alachua, Broward, Charlotte, Columbia, Duval, Flagler, FAU Lab School, Hillsborough, St. Lucie, Leon, Dade, Orange, Osceola, Palm Beach, Santa Rosa, Seminole, Volusia
Modeling and Simulation Club	9	Brevard, Broward, FAU Lab School, Hillsborough, Orange, Palm Beach, St. Lucie, Santa Rosa, Seminole
SECME	6	Alachua, Brevard, Dade, Orange, Osceola, Palm Beach
Vex Robotics	5	Alachua, Orange, Palm Beach, Seminole
Robotics (not FIRST or Vex)	5	Clay, Hillsborough, Palm Beach, Santa Rosa, Volusia
STEM Clubs	4	Charlotte, Orange, Palm Beach
Coding	4	Broward, Clay, Flagler, Osceola
Science	4	Leon, St. Lucie, Santa Rosa, Washington
Technology Student Association	3	Brevard, Osceola, Volusia
4-H Club	2	Broward, Palm Beach

Math Counts	2	Clay, Seminole
Odyssey of the Mind	1	Bradford
WeatherSTEM	1	Baker
RasberryPi	1	Brevard
Computer Science	1	Broward
Elementary Science Club	1	Charlotte
Math Team	1	Clay
Astronomy	1	Nassau

Next the researcher determined the number of activities per district based on the survey results. The full results are provided in Appendix G, Table 30. Table 23 displays the top seven districts with the most STEM activities.

Table 23. Florida Districts with the Most STEM activities

District	Number of STEM Activities
Orange	17
Palm Beach	14
Seminole	12
St. Lucie	11
Broward	10
Hillsborough	9
Osceola	9

The researcher found 40 districts were represented with STEM activities in the survey. The researcher then downloaded student performance results from the FLDOE District Science Demographic Report from the 40 districts. Of those 40 districts, personnel in 35 districts reported

8th Grade Florida Science Assessment results for students with disabilities. Consequently, the researcher included 35 districts in the analysis.

The researcher used correlational research to determine the relationship between the number of STEM activities and the 8th Grade Science Assessment of SWD. Districts whose representatives did not respond to the survey were eliminated from the analysis. The resulting data were generated from survey responses and the 2015 8th Grade Florida Science Scores from the participating districts ($n = 35$). The researcher computed a Pearson correlation coefficient to determine if a relationship exists between the number of STEM activities offered in a district and 8th Grade Florida Science Assessments for SWD. The test was conducted using an alpha of 0.05. The null hypothesis was that the relationship would be zero. With each statistical analysis a set of assumptions must be satisfied or addressed prior to running the analysis. For a Pearson's Correlation, the following assumptions must be satisfied: linearity, no significant outliers, and normality (Laerd Statistics, 2015).

Research Question 4 Assumptions

Variables

Data from the number of STEM activities per district and the means scores of SWD from each district are considered continuous variables. As a result, the assumption of continuous variables was met.

Pairing of Variables

The researcher disaggregated the data by district which is considered the case. Each case or district has two values, one for the mean scores of SWD and one for the number of STEM activities.

Outliers

The researcher generated a boxplot noting outliers for each variable because Pearson's correlation coefficient is sensitive to outliers. The resulting boxplot did not display any outliers in the data for activities however, there were three outliers for the mean scores for SWD as noted in Figure 14. A Grubb's test (1950) was performed to detect outliers and the three outliers were not statistically significant as an outlier ($p > 0.05$). As a result, the outliers remained in the data analysis.

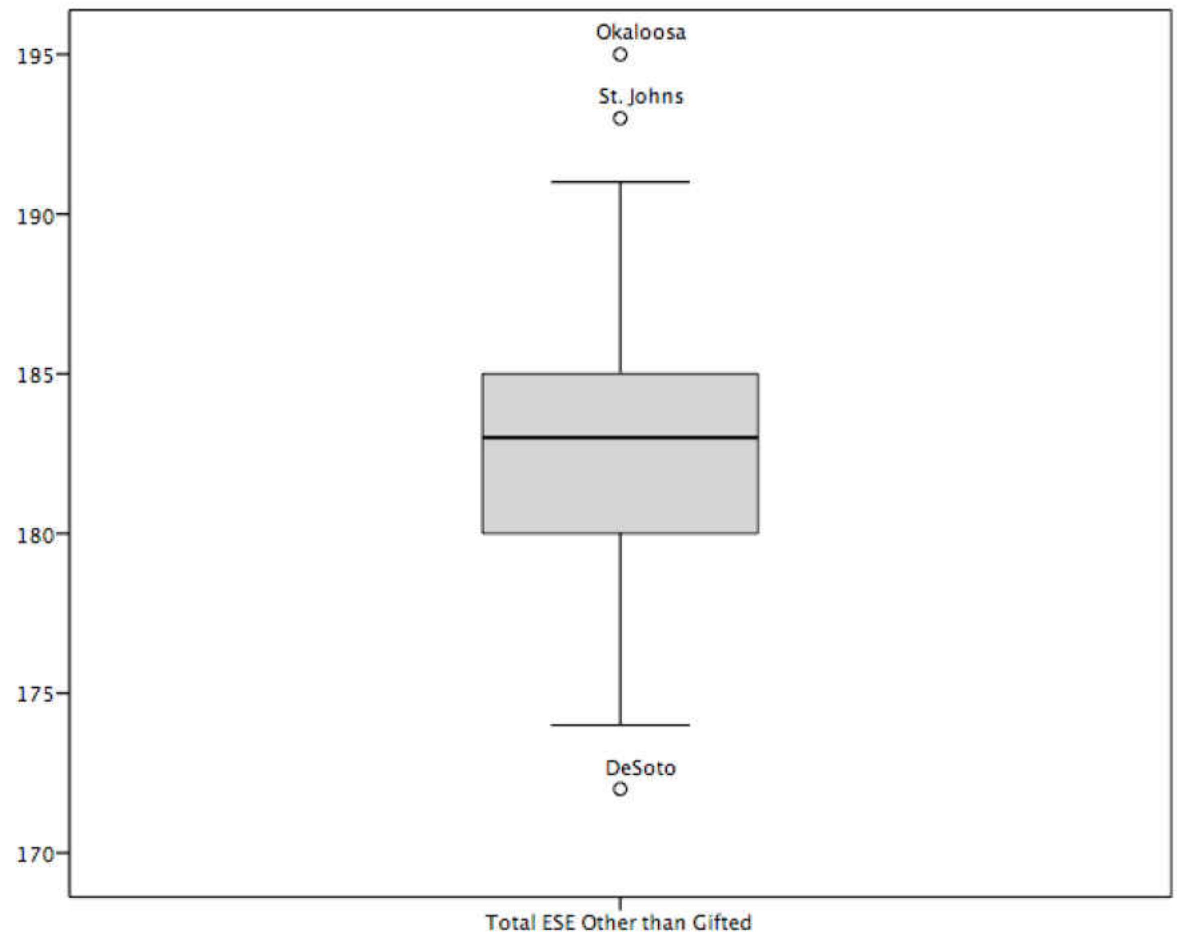

Figure 14. Distributions of 8th Grade Science Assessment scores for SWD.

Linearity

The assumption of linearity was weak given a review of the scatterplot of variables (Figure 15). A straight line with a linearity of 0.055 provided a small yet reasonable fit to the data.

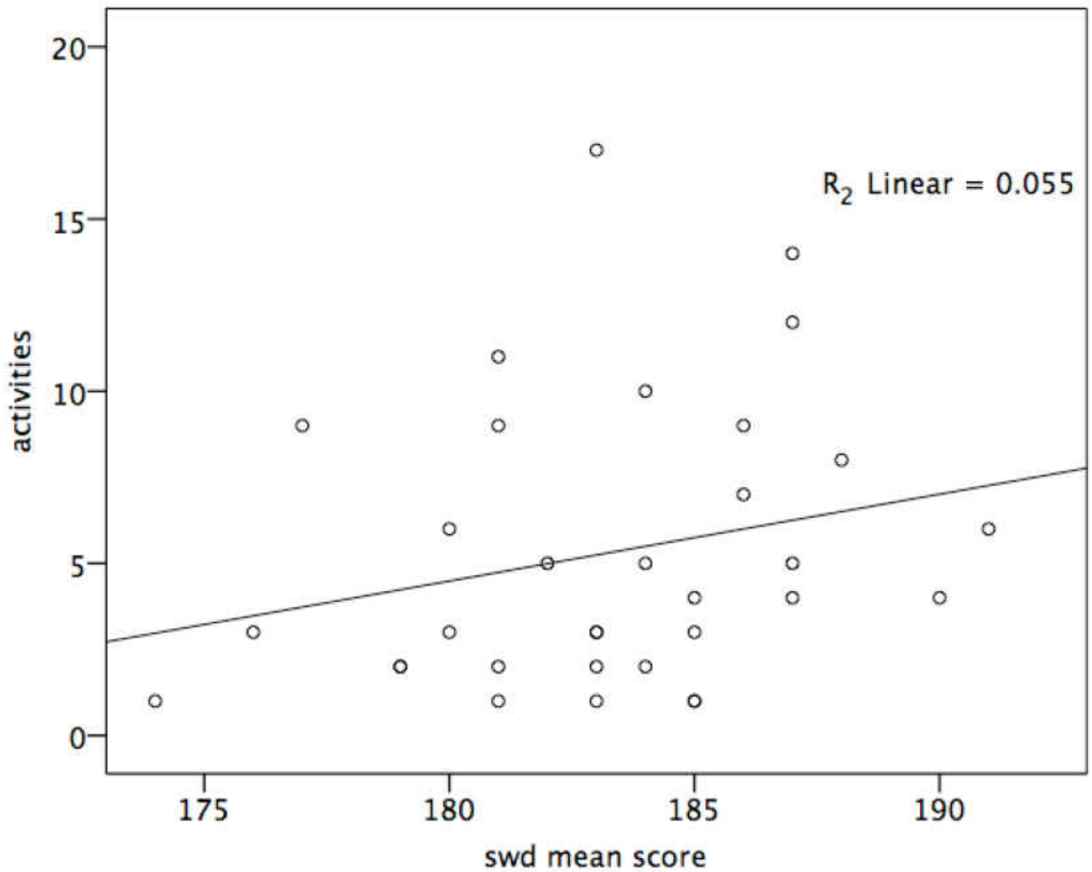

Figure 15. Scatter plot of SWD and number of STEM activities offered.

Normality

As shown in Table 24, not all variables were normally distributed as assessed by Shapiro-Wilk's test ($p < .05$). The assumption of normality was met for activities, but not for the mean scores of SWD. Even though the assumption of normality was violated for the mean science scores, a Pearson's Correlation Coefficient will be calculated because the test is somewhat robust to deviations from normality (Laerd Statistics, 2016).

Table 24. Tests of Normality

	Shapiro-Wilk		
	Statistic	*df*	Sig.
Activities	.880	33	.002
SWD Mean Score	.983	33	.877

Note. SWD = students with disabilities

Table 25. Pearson's Correlation Coefficient

		Activities	SWD mean score
Activities	Pearson's Correlation	1	.235
	Sig. (2-tailed)		.189
	N	33	33
SWD Mean Score	Pearson's Correlation	.235	1
	Sig. (2-tailed)	.189	
	N	33	33

Research Question 4 Results

As shown in Table 25, the Pearson's Correlation between SWD scores on the 2015 8^{th} Grade Florida Science Assessment and number of STEM activities in 33 Florida districts was 0.235, which is positive, is interpreted as a small effect size (Cohen, 1988), and is statistically different from 0 (r = 0.235, n = 35, p = 0.189). The null hypothesis that the correlation is zero, however could not be rejected at the .05 level of significance. The observed power was .189, which indicated a Type I error may be possible, but was not likely. Thus the null hypothesis that the correlation is 0 could not be rejected at the .05 level of significance. There is a small, positive correlation between the number of STEM activities offered in a district and the 2015 8th Grade Florida Science Assessment scores. The number of STEM activities offered in a district explained 6% of the variation in the 2015 8th Grade Florida Science Assessment scores. The variance is calculated by squaring the correlation coefficient ($r = 0.235$).

As a result of the of the small effect size, science fair was removed from the number of activities in each districts and the Pearson's Correlation Coefficient was calculated again. The revised results were presented in Table 26.

Table 26. Revised Pearson's Correlation

		SWD Mean Score	Activities
SWD Mean Score	Pearson's Correlation	1	.210
	Sig. (2-tailed)		.274
	N	29	29
Activities	Pearson's Correlation	.210	1
	Sig. (2-tailed)	.274	
	N	29	31

As shown in Table 26, the revised Pearson's correlation between SWD scores on the 2015 8th Grade Florida Science Assessment and number of STEM activities in 29 Florida districts was 0.210, which is positive, is interpreted as a small effect size (Cohen, 1988), and is statistically different from 0 ($r = 0.210$, $n = 29$, $p = 0.274$). The null hypothesis that the correlation is zero, however could not be rejected at the .05 level of significance. The observed power was .274, which indicated a Type I error may be possible. Thus the null hypothesis that the correlation is 0 could not be rejected at the .05 level of significance. There is a small, positive correlation between the number of STEM activities offered in a district and the 2015 8th Grade Florida Science Assessment scores. The number of STEM activities offered in a district explained 4% of the variation in the 2015 8th Grade Florida Science Assessment scores. The variance is calculated by squaring the correlation coefficient ($r = 0.210$).

Reliability

Reliability data were collected at three points in this study. Checkpoint one was completed prior to the current study. The questionnaire was validated with a pilot study and a review by experts in the field. Content validity evidence for the survey questionnaire was obtained from written comments provided by pilot participants and critiques of the questionnaire by experts with special education and STEM backgrounds. Reliability measures for checkpoint two involved an interrater review of 30% of the data entered from data sources for the SPSS statistical analysis. The data sources were the results from the questionnaire and the 2015 8th Grade Florida Science Assessment from the FLDOE. Reliability was established by the researcher at 100% for the entered data. Finally, the researcher evaluated each analysis for reliability to satisfy the third checkpoint. As stated in Chapter 3, the researcher accounted for reliability of the questionnaire by examining consistency in responses across district responses.

Summary of Data Analysis

Statistical analysis by the researcher found there was a statistically significant difference between students with and without disabilities on the 2015 8th Grade Florida Science Assessment. Additionally, participants in the electronic questionnaire stated they typically do not track the number of SWD who participate in STEM activities in their districts and the students who do participate generally have learning disabilities. Lastly, researcher analysis resulted in a small correlation between the number of STEM programs offered in a district and the SWD outcomes on the 2015 8th Grade Florida Science Assessment.

CHAPTER FIVE: DISCUSSION

Introduction

Summarized in this chapter are the researcher's investigation of the differences between students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the types of STEM activities districts offer along with the percentage of SWD who participate in those STEM activities. Lastly, the researcher summarized the relationship between the number of STEM activities in a district and the results on the 8th Grade Florida Science Assessment scores for SWD. In this chapter the following sections are included to frame the relevant components of the study: statement of the problem, purpose, summary of the study, review of methodology, summary of the results, discussion of the findings, limitations and design control, implications and recommendations.

Statement of the Problem

Individuals with STEM knowledge, skills, and abilities drive innovation that will lead to new products, industries, and economic growth (BHED/Act Policy Brief, 2014; National Academies of Sciences, Engineering, and Medicine, 2016; National Science Board, 2015). Additionally, those individuals need to be diverse because the number of occupations requiring

STEM capabilities is growing. Klowden and colleagues (2014) reported global competition in technology and science is crucial, considering the increased reliance on innovation. If Florida is to continue to prosper, all students must be prepared for the global economy they will inherit.

Indeed, there is a clear need for more diverse STEM workers. However, only 5% of SWD enter the STEM workforce (Leddy, 2010). In 2011, Newman et al., identified 6% of undergraduate SWD reported majors in science or computer-related areas and less than 9% reported majors in engineering. One reason SWD do not enter the STEM workforce is they struggle in science, specifically in middle school where the decision is often made to pursue advanced science and engineering courses (Hartung, Porfeli, & Vondracek, 2008). Specifically, there is a sustained statistically significant achievement gap between students with disabilities and their nondisabled peers in science (NCES, 2011).

The Current State of Science Instruction

Currently, 61% of all SWD are included for 80% or more of the day in general education classes (U.S. Department of Education, 2016). Given that more SWD are being included in the general education classroom, more SWD are exposed to the same curriculum and expected to meet the same rigorous standards in science as their peers without disabilities. However, SWD have consistently underperformed in science compared to their peers (U.S. Department of Education, 2013). As stated in chapter 1, there is a disparity in science achievement of SWD due to the recent shift to the NGSS and College and Career Readiness Standards in Florida. This shift has placed more focus on student acquisition of science content through activities such as (a) asking questions and defining problems; (b) developing and using models; (c) planning and carrying out investigations; (d) analyzing and interpreting data; (e) using mathematics and computational thinking; (f) constructing explanations and designing solutions; (g) engaging in argument from evidence; and (h) obtaining, evaluating, and communicating information (FLDOE, 2012). New standards and curriculum have increased the amount of academic rigor and expectations for all students.

As noted in Chapter 1, accommodations and technology help SWD develop stronger procedural skills, apply organizational strategies, and transfer reading and mathematics skills to the science content area however, the accommodations do not always address scientific thinking (Mutch-Jones, Puttick, & Miner, 2012; Stefanich, 2007). The increased demands on the science content can lead to SWD experiencing the loss of future STEM opportunities (Mastropieri et al., 2006).

Purpose of the Study

The purpose of the current study was to determine if significant differences existed between students with and without disabilities on the 2015 8th Grade Florida Science Assessment, the types of STEM activities offered in a district, and the percentage and type of SWD who participate in STEM activities in each district. Furthermore, the researcher examined the relationship between the number of STEM activities in a district and SWD achievement on the 2015 8th Grade Florida Science Assessment. Students who participate in extracurricular activities have better outcomes than students who do not participate (Durlak, Weissberg, & Pachan, 2010). It is well documented that participation in informal science learning experiences has a positive influence on participants' attitudes about science (Antink-Meyer, Bartos, Lederman, & Lederman, 2014; Bhattacharyya, Mead, & Nathaniel, 2011; Bischoff, Castendyk, Gallagher, Schamloffel, & Labroo, 2008; Fields, 2009; Luehmann, 2009). However, students with disabilities are underrepresented in extracurricular activities and struggle with middle school science (Brigman, Webb, & Campbell, 2007; National Center for Educational Statistics, 2015; U. S. Government Accountability Office, 2013). As a result, more research is needed in the area of science, extracurricular activities, and SWD (Shields et al., 2014). The findings from this investigation should assist policymakers, administrators, and teachers in understanding the relationship between extracurricular activities and SWD performance in science. Findings should also add to the general knowledge and understanding of extracurricular activities and their impact on SWD.

The research and design of the current study were guided by the following questions:

- RQ1: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science assessment?
- RQ2: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities?
- RQ3: What disability category do school personnel report as having the highest level of participation during after-school STEM activities?

- RQ4: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment?

  The following null research hypotheses, which related to the stated research questions, were explored by the researcher in the study:

- RQ1: There is no difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment.
- RQ2: School personnel will report a large percentage of SWD participating in after-school STEM activities.
- RQ3: School personnel will report students with LD as having the lowest level of participation in after-school STEM activities.
- RQ4: There is no correlation between the number of STEM activities offered and SWD achievement on the 2015 8th Grade Science assessment.

The framing of the research questions and the related hypotheses were supported through the review of literature associated with STEM, extracurricular activities, and SWD. The relative void in the literature with regard to studying extracurricular activities and SWD led to designing questions and hypotheses intended to measure the correlation between extracurricular activities and SWD outcomes on the 2015 8th Grade Florida Science Assessment.

Summary of the Study

Based on the researcher's review of the related literature conducted for this study it is clear researchers have given considerable attention to SWD and science (i.e., Kaldenberg, Watt, & Therrien 2015; Marino, et al., 2014; Benedek-Wood, Mason, Wood, Hoffman, & McGuire 2014). According to the NAEP (NCES, 2011), students with disabilities score below their peers in science. There are many reasons for the achievement gap including a weakness in reading and problem solving abilities in inquiry based classes (Marino, 2010). While much of the research focused on understanding SWD and science, relatively little was found in the existing body of knowledge with regards to understanding STEM activities and SWD outcomes on standardized assessments.

The researcher conducted a literature review on the current funded projects and publications from IES and NSF. The researcher found a majority of the projects focused on post-secondary accommodations. The primary research focus was assistive technology. Next, the researcher explained the NGSS, NETS, and NES and the rigor associated with the new standards. The researcher explained how SWD lag behind their peers both nationally and in Florida in the area of STEM using NAEP and FCAT scores.

The theoretical framework for the current study was determined by the researcher through a literature review of studies relating to STEM, science, and extracurricular activities. The procedures were embedded in 21st Century Learning and social constructivism. All of the theories follow the ideas of constructivism, specifically social constructivism since most STEM extracurricular activities are based on deriving knowledge within a social context. Furthermore, the researcher found that companies value employees with strong collaboration and social skills (American Institutes for Research [AIR], 2013). The researcher also identified a need for SWD to increase their self-efficacy and self-determination skills. Students with disabilities who wish to pursue postsecondary education in STEM need support in self-advocacy and self-determination skills (Grigal & Hart, 2010).

Next the researcher reported the reasons for the achievement gap between students with and without disabilities in science. Researchers suggest reading levels as well as difficulties with executive functioning contribute to SWD inability to master science content (Dexter & Hughes, 2011; Graeser, McNamara, & Kulikowich, 2011; Gajria et al., 2007). The IES and NSF researchers noted accommodations and assistive technology can help some students with disabilities, however more research is needed as shown by the consistent discrepancy between SWD and their peers in science. The researcher discovered students in middle school are at a critical time and are expected to articulate a future career (Hartung et al., 2008; Kesidou & Roseman, 2002). Furthermore, SWD are not graduating from high school and are not employed at the same rate as their non-disabled peers as College and Career Readiness Standards become more rigorous (Hartung et al., 2002).

An economy based on the understanding of STEM is replacing traditional manufacturing (Kaku, 2011). Science, technology, engineering, and mathematics education plays a critical role in shaping economic development through innovation (Cooper & Heaverlo, 2013). Due to barriers to access STEM programs, SWD have been excluded from postsecondary STEM education (Burgstahler, 1994; Moon et al., 2012).

A promising practice for learning science is through informal learning environments like extracurricular activities. Learning science in non-school settings is often overlooked (Bell, Lewenstein, Shouse, & Feder, 2009). As a result, the Board of Science Education established the Committee on Successful Out of School STEM learning to examine the potential of non-school settings for science learning (NRC, 2015). Extracurricular STEM activities have been associated with improved academic performance and psychosocial development (Durlak et al., 2010). However, many SWD were not given an equal opportunity to participate in extracurricular activities (U.S. GAO, 2010).

The researcher selected the state of Florida because Florida has the third largest population and has many STEM related job postings. Furthermore, Florida ranks low on the Milken State Technology and Science Index (Klowden et al., 2014). As a result of the literature review, the researcher decided to analyze extracurricular STEM activities and SWD performance on the 2015 8th Grade Florida Science Assessment.

Review of Methodology

As explained in Chapter 3, the researcher used an exploratory, quasi-experimental design in the current study, in which data from the Florida 8th Grade Science Assessment results were analyzed and correlated with a survey answered by STEM educators. After Institutional Review

Board approval was received, the researcher contacted the STEM director for the State of Florida. The researcher and STEM director collaborated on the development of the questionnaire. Next, the STEM director sent the electronic questionnaire to each district science director in the state of Florida with instructions to forward it to STEM personnel. Two weeks after the initial e-mail, the STEM director sent a reminder to the science directors. The results were responses from 489 district personnel from most of the 76 Florida school districts. The responses to the questionnaire were used to answer research questions 2, 3, and 4. Data from the 2015 8th Grade Florida Science Assessment reported by the FLDOE (2016) were used to answer research questions 1 and 4.

Data were analyzed by the researcher using descriptive statistics, independent samples *t*-tests, and correlation matrices. An independent samples *t* test was used to analyze the difference between students with and without disabilities results on the 2015 8th Grade Florida science assessment for research question 1. The researcher used descriptive statistics to analyze survey data used in research questions 2 and 3. A bivariate correlation was calculated between the results of the 2015 8th Grade Florida Science Assessment and the number of STEM activities offered per district to answer research question 4.

Summary of the Results

Research Question 1

The first research question asked the following: Is there a statistically significant difference between the performance of students with and without disabilities on the 2015 8th Grade Florida Science Assessment? Hypothesis 1 stated there would be a statistically significant difference between students with and without disabilities on the 8^{th} Grade Science Assessment. The null hypothesis was rejected based on the independent samples *t* test analysis, there was a statistically significant difference between the variables.

The question was answered with student performance data accessed from the FLDOE website using an independent samples *t* test. The researcher tested assumptions for normality, homogeneity of variance, and independence on each variable prior to running the analysis. Because the assumption of normality was not met in the first analysis on all 2015 8^{th} Grade students, the researcher examined a boxplot and performed a Grubb's test. Consequently, the researcher determined outliers were causing the abnormal distribution. As a result, the researcher removed the outliers, which were more than two standard deviations from the mean. The resulting analysis revealed the assumption of normality was met when outliers were removed on the results of the Florida Science Assessment for all 8^{th} grade students. The assumption of normality was met for SWD and an analysis of the districts with outlying science scores was performed.

The outliers in the data included the districts of St. Johns (*m* = 214, *n* = 2699), Hamilton (*m* = 186, *n* = 130), Madison, (*m* = 185, *n* = 141), Florida School for the Deaf and Blind (FSDB; *m* = 176, *n* = 32), and Jefferson (*m* = 177, *n* = 48). To further analyze the data on the outliers the Table 27 was generated on the outlying districts.

Table 27. Demographics of Outlying Districts

District		Number of students	Mean Scale Score	% in Achievement Level > 3	% of State Population
Hamilton					
	Students	130	186	18%	0.07%
	SWD	18	174	6%	0.08%
Jefferson					
	Students	48	177	10%	0.02%
	SWD	7	*	*	0.03%
Madison					
	Students	141	185	14%	0.07%
	SWD	27	174	7%	0.12%
St. Johns					
	Students	2699	215	76%	1.37%
	SWD	307	193	33%	1.42%
FSDB					
	Students	32	176	9%	0.09%
	SWD	32	176	9%	0.15%

Note. No data are reported when fewer than 10 students were tested

With the exception of St. Johns, which scored more than two standard deviations above the mean on the SWD 8th grade science assessment scores, the other four districts are very small compared to the mean district size of 2,587 8th grade students and 283 8th grade SWD. As a result, more research should be conducted on the reasons why SWD perform better in St. Johns than other districts. Additionally, more research should be conducted on the science scores of 8th

SWD who reside in small districts to see why they score significantly lower (greater than two standard deviations) than the average district.

The assumption of homogeneity was met as indicated by an insignificant Levene's test. Because there was no random assignment, the assumption of independence was not met. Violation of the independence assumption created potential for an increased probability of a Type I or Type II error. Based on of G*power version 3.1.9.2 (Faul et al., 2009), analysis, the suggested sample size was 26 districts for each group for an independent samples *t* test using two different samples. The resulting analysis determined the mean scores between SWD and all 8th grade Students on the 8th Grade Florida Science Assessment was statistically significant with a large effect size. The results provided evidence that SWD score lower than students without disabilities on the 2015 8th Grade Florida Science Assessment.

Research Question 2

The second research question asked the following: What percentage of students with disabilities do school personnel report as participating in after-school STEM activities? Hypothesis 2 stated school personnel will report a small percentage of SWD participating in after-school STEM activities. The null hypothesis was rejected based on the descriptive statistics used to analyze the responses from 230 school STEM personnel who answered the question. Of the 230 respondents, 173 or 75% reported their district does not track the number of SWD in their STEM clubs and 47 or 20% stated 0-20% of SWD participate in STEM activities.

Research Question 3

The third research question asked the following: What disability category do school personnel report as having the highest level of participation during after-school STEM activities? Hypothesis 3 stated the disability category having the highest level of participation during after-school STEM activities was LD. The null hypothesis was rejected based on the descriptive statistics used to analyze the responses from the 75 respondents who answered the survey question. Of the 75 responses, 42 or 56% selected LD.

Research Question 4

The last research question asked the following: What is the relationship between the number of STEM activities in a district and students with disabilities' achievement on the 8th Grade Florida Statewide Science Assessment? Hypothesis 4 stated there will be a small correlation between the number of STEM activities offered and SWD achievement on the 2015 8^{th} Grade Science assessment. The null hypothesis of a zero correlation, however, was not rejected based on the analysis of a Pearson Correlation Coefficient because the observed power was .189, which indicates a Type I error may be possible. Thus the researcher could not reject the null hypothesis that the correlation is zero at the .05 level of significance. There was a small positive correlation between the number of STEM activities districts offered and SWD 2015 8th Grade Florida Science Assessment scores. The number of STEM activities offered in a district explained 8% of the variation in the 2015 8th Grade Florida Science Assessment scores. Specifically, the number of STEM activities offered in a district explained 8% of the variance in the test scores. Alternatively, 92% of the variance in scores of SWD was not explained by the number of STEM activities in the students' school district.

The question was answered by the researcher with student performance data accessed from the FLDOE website and the results of an electronic questionnaire distributed to school STEM personnel. Assumptions for variables, outliers, linearity, and normality were tested by the researcher on each variable prior to running the analysis. Assumptions for variables were met. Assumptions of normality was met for STEM activities but not the 8th Grade Science Florida Assessment mean scores of SWD based on the Shapiro-Wilk's test.

Even though the assumption of normality was violated for the mean science scores, a Pearson's Correlation Coefficient was calculated because the test is somewhat robust to deviations from normality (Laerd Statistics, 2016). The Pearson Correlation Coefficient (r = 0.235) is interpreted as a small effect size (Cohen, 1988). Due to the small effect size a revised Pearson's Correlation Coefficient was calculated after removing science fair from the data. The revised results (r = .210) is also interpreted as a small effect size (Cohen, 1988). Figure XX is a flow chart of the steps the researcher took to evaluate RQ4.

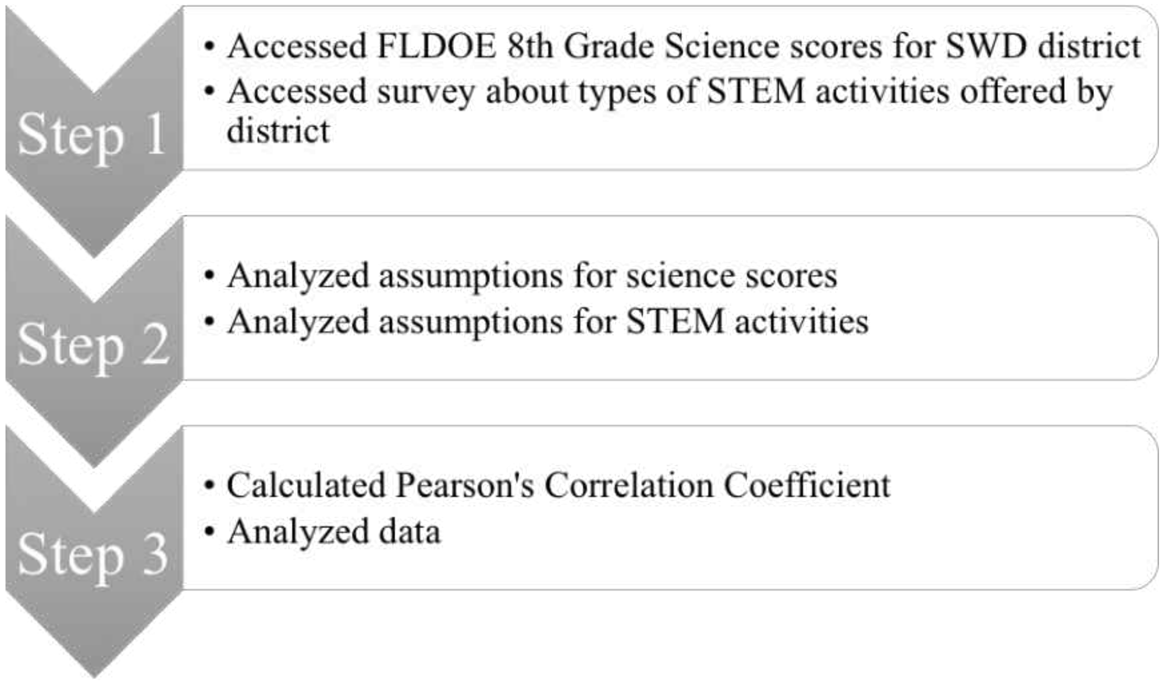

Figure 16. Flowchart of Steps to Analyze RQ4

Discussion of the Results

Interpretation of the Findings

Analysis of RQ1 added to the research that there is a statistically significant difference between students with and without disabilities on the 8th grade Florida Science Assessment. The results align with what is found in the literature with the history of performance on standardized science assessments between students with and without disabilities in both Florida and the nation. The current study adds to the field of research that SWD continue to struggle in science in the state of Florida. Furthermore, outliers were present in the data from smaller school districts, indicating students from smaller districts perform worse than their peers from larger districts on the Florida Science assessment.

Analysis of RQ2, resulted in data that explains the paucity of information on the number of SWD who participate in STEM activities. Until schools and district personnel track the number of SWD who participate in STEM activities, researchers will not be able to determine if STEM activities benefit them, specifically when correlated with student outcomes on standardized assessments. School and district personnel should track the number of SWD who participate in STEM activities. Without the data, research on the effectiveness of such activities will not be robust.

For research question 3, the researcher determined the type of SWD represented in STEM activities. According to the U.S. Department of Education (2014), 35% of all children and youth receiving special education services were categorized as having SLD in 2012-2013. Given most students served under IDEA have LD, students with LD as expected represented the disability category having the highest level of participation in afterschool STEM activities. Additionally, researchers at NCES (2015) reported 66.2% of students with LD spent 80% or more of their time in inclusion classrooms in the fall of 2011, the latest figures reported. Students with LD were more likely to spend most of their time in inclusion classrooms than any other disability category. Specifically, more than 80% of students with LD, receive their science instruction in the general education setting (Aud et al., 2012). As a result, the fact that district and school personnel in this study reported students with LD represent the most SWD who participate in

STEM activities lends strength to the robustness of the survey as it follows the national trend for students with disabilities and inclusion. However, only 75 of the 489 respondents (15%) who began the survey answered the question. Further analysis needs to be conducted to determine why so many respondents skipped this question.

For RQ4, the researcher found the number of STEM activities in a district and the outcomes of SWD on the 8^{th} Grade 2015 Florida Science assessment did have a small correlation ($r = 0.235$) between the two variables. It is concerning that power was not met and thus rejecting the null hypothesis of no correlation at the .05 significance level cannot be accomplished by the researcher. The observed power was .189, which indicated a Type I error may be possible, but was not likely. Thus the null hypothesis that the correlation is zero could not be rejected at the .05 level of significance. In other words, failure to reject the null hypothesis, because there is no correlation between the performance of SWD on the 8^{th} Grade Florida Science Assessment and the number of STEM activities offered in a district implies further analysis and research is needed. A possibility exists of a correlation between the two variables, despite the evidence from a single sample (Gall et al., 2012). Even if the researcher had set a higher significance level, the null hypothesis could not be rejected due to the high *p* value, which indicates a Type I error may be possible. Because the researcher selected a .05 level, there is a 1 in 5 chances occur that the researcher will reject the null hypothesis when, in fact, the statistical evidence does not justify its rejection (Gall et al., 2007). If the rejection of the null hypothesis is unwarranted, it is called a Type I error (Cowles & Davis, 1982). Because none of the samples were randomly drawn or assigned, the use of tests of statistical significance is questionable. Furthermore, inferences cannot be made as a result of the current quasi experimental, exploratory research. As a result, replications of the current study should be completed to attain additional information and assurance that the observed results are real. Cohen (1990) suggests future replication of the variables in the same and different settings will provide a more informed judgment of the research.

Relationship of the Current Study to Previous Research

Previous researchers also determined SWD lag behind their peers in science (i.e. Kaldenberg et al., 2015; Fleischman, Hopstock, Pelczar, & Shelley, 2010; Thornton, McKissick, Spooner, Lo, & Anderson, 2015; US DOE, 2016). There is a sustained, statistically significant achievement gap between SWD and their nondisabled peers in science (NCES, 2011). Researchers report many reasons students do not meet grade level standards in science including (a) increased demands in learning material with a shift to expository text, (b) executive functioning difficulties, and (c) a reliability on inductive and deductive reasoning in science (Dexter & Hughes, 2011; Graesser et al., 2011; Gajria et al., 2007; Marino, 2010; Mastropieri et al., 2006; Street et al., 2012). In spite of these challenges, accommodations have been shown to be successful for students with disabilities (Cameto Knokey, & Sanford, 2011; Campbell, Wang, & Algozzine, 2010; Carter, Prater, & Dyches, 2008). Accommodations, however, do not always address scientific thinking (Mutch-Jones, Puttick, & Miner, 2012). The increased demands on the science content can lead to frustration, academic failure, loss of access to the general education curriculum, and loss of future STEM opportunities for SWD (Mastropieri et al., 2006). As a result, many SWD are not encouraged to take higher level science courses (Burgstahler & Change, 2009).

Research to increase SWD participation in STEM has traditionally focused on Universal Design for Learning (UDL) and technology (Burrelli, 2007; Leddy, 2010). Universal Design for Learning is a curriculum and pedagogical design framework that proactively addresses student diversity (Rose, Meyer, & Hitchcock, 2005). The Center for Applied Special Technology (CAST; 2011) described three core principles which call for multiple means of (a) representation, (b) action and expression, and (c) engagement. Policymakers, however have begun to look outside the walls of the traditional school buildings (NRC, 2015). As a result, there has been a focus on the learning outcomes of students who participate in informal learning environments (NRC, 2015). Every year millions of Americans explore science by visiting informal learning institutions (Bell et al., 2009). As a result, the Committee on Successful Out of School STEM Learning was established by the Board of Science Education to examine the potential for informal science learning (NRC, 2015).

Out of school programs have been shown to (a) reduce the achievement gap by socioeconomic status; (b) connect youth to adults to serve as mentors and role models; and (c) contribute to student's interest in and understanding of STEM (NRC, 2015). Researchers have shown students who participate in extracurricular activities have better outcomes than students who do not participate (Durlak et al., 2010). In 2001, the Council for Exceptional Children (CEC) reported SWD who participated in extracurricular activities developed self-confidence and other skills. Wagner, Caldwallader, Newman, and Marder (2003) pointed out IDEA requires schools to provide access to extra-curricular activities through their IEPs. However, SWD are underrepresented in extracurricular activities and struggle with middle school science (Brigman, Webb, & Campbell, 2007; Mastropieri, et al., 2006; U. S. Government Accountability Office, 2013).

After a review of current NSF and IES grants, the researcher was not able to locate any on the constructs of science, extracurricular activities, and SWD. One IES grant, written by Kelly Hallberg for approximately $400,000 is studying expanded learning time, however the expanded time is an extension of the school day by 40 minutes. The student learning is formal in the research. Other grants focus on College and Career Standards, middle school literacy, high incidence disabilities in high school, and self-determination. Several researchers focused on middle school SWD including students with emotional and behavior disorders, in self-contained mathematics classes and professional development for middle school science teachers.

Current NSF grants are studying middle school science and students with LD, the STEM gender achievement gap and interventions, interactive science simulations for middle school SWD, post-secondary STEM enrollment and high school STEM persistence. Other researchers, like William Mann from the University of Florida, was granted $846,000 to study STEM and learning disabilities in undergraduate students. Other researchers are studying online learning environments for SWD, undergraduate black women in STEM, STEM skills acquired during high school, and barriers to entry to the STEM workforce.

Publications from the above current NSF and IES grants include mathematic interventions for middle school SWD (Bottge et al., 2015; Bottge, Ma, Gassaway, Toland, Butler, & Cho, 2014; Bottge, Ma, Gassaway, Butler, & Toland, 2014). The results are SWD who had teachers using enhanced anchor instruction performed better than the control group. Another publication about co-teaching in a chemistry class using UDL resulted in higher scores for SWD (King-Sears et al., 2015). Rabren, Carpenter, Dunn, & Carney (2014) published an article on the post school outcomes of former high school students with SLD or intellectual disabilities and found gender, race, least restrictive environment, job status in high school, and participation in career technical education were significant in a factor analysis. Rojewski, Lee, and Gregg (2015) and Lee, Rojewski, Gregg, & Jong (2014) published studies on post school outcomes on inclusion of students with LD and emotional and behavioral disabilities using the NLTS-2 dataset. The researchers found a significant association between inclusion and post-secondary education and grade point average. Additionally, they found socioeconomic status and number of friends planning to attend college were a significant predictor of educational persistence. Additionally, Jenson, Petri, Day, Truman, and Duffy (2010) reported on a focus group of post-secondary SWD on their self-efficacy skills. They found faculty and student relationships play an important role in self-efficacy of SWD. Lastly, Wei, Lenz, & Blackorby (2013) and Wei, Yu, Shattuck, McCracken, & Blackorby (2013) used the SEELS and NLTS-2 databases to determine mathematics achievement and STEM participation of SWD. They found students with speech and visual disabilities had the highest mathematics achievement and multiple disabilities and intellectual disabilities had the lowest. They also reported young adults with ASD who attend college are more likely to pursue STEM majors than other disabilities, specifically science and computer science. While there are many current NSF and IES funded studies on SWD, none were found on SWD and informal learning environments.

Recommendations

Additional research is needed on STEM activities and their impact on SWD performance on standardized science assessments. As noted, it is possible that STEM activities can increase student scores. However, there is a dearth in the scientific research on the impacts of STEM activities and SWD. As a result of the outcomes of the current study, the researcher suggests STEM activities may be beneficial to students with disabilities performance in science. Based on the findings, the researcher recommends district personnel track the number and disability category of SWD who participate in extracurricular STEM activities. These data are needed to conduct more robust research in the area of informal STEM learning and SWD.

It is recommended the current research is replicated in other states that have less variability in district size. Given the outliers were mostly small districts which underperformed compared to larger districts, the variability of district size was a variable that could possibly be controlled for in a state with a more homogeneous sample of districts to sample. The size and resources of the different school districts should be considered. It is also recommended more targeted research be conducted within a single district to determine if a correlation exists between different schools in a district. A single district study could possibly control for more variables like teacher preparation, teacher quality, student demographics, etc.

Implications

for Practice

Given the current climate of science education, SWD will continue to fall even further behind if educators do not identify activities that help SWD become successful in science. Researchers have studied the effects of extracurricular activities on students with promising results (Mahoney, Levine, & Hinga, 2010; Vandell, Reisner & Pierce, 2007). However, very few studies have focused on the effects of extracurricular activities on SWD (see Appendix C). Given this paucity in research, a need exists to identify if STEM activities make a difference on the outcomes of SWD on standardized science assessments.

District and school personnel who can increase secondary STEM participation of SWD can impact employment rates in STEM fields. According to Leddy (2010), only 5% of SWD enter the STEM workforce. One reason SWD do not enter the STEM workforce is they struggle in science, specifically in middle school where the decision is often made to pursue advanced science and engineering courses (Hartung et al., 2008).

Researchers in the field of special education have attempted to alleviate the disparity in science performance between SWD and their non-disabled peers by investigating and implementing instructional interventions (Israel, Wang, & Marino, 2015; Marino, Coyne, & Dunn, 2010; Seifert & Espin, 2012). Two of the most heavily researched interventions in STEM are technology and UDL (see Appendix C). An extensive research base of studies funded by the NSF and the IES suggested technology and UDL is beneficial to SWD who struggle in science. In a thorough review of approximately 17 studies, the researcher found technology and UDL can have a positive impact on SWD, especially students with LD (see Appendix C). As a result of the analyses conducted in this study, the researcher suggests that informal learning environments, specifically STEM activities, can also increase SWD outcomes in science.

for Policy

Policy is often created through research. Unfortunately, national studies fail to report extracurricular STEM activities and SWD. Due the the lack of information, policies to close the achievement gap between students with and without disability using STEM activities are nonexistent. Students with disabilities continue to be marginalized, thus continuing the historical treatment of SWD, further exasperating the difference between standardized science scores. Although national studies, as well as seminal works should be referred to when making policy decision regarding informal science learning and SWD, the results found herein also can be used to make changes in the grim statistics that surround SWD and their performance in science and STEM employment. The quantitative results of the current study present a clear image of the difference between SWD and their peers in the area of science and the slight correlation between standardized science assessments and the number of STEM activities a district offers. By looking at the data, policy makers can ensure these variables are addressed when post-secondary options, high school dropout rates, and overall school outcomes are being examined for change. These results indicate if policymakers consider this study and provide support for informal STEM learning environments, SWD could be more likely to select more rigorous high school science courses, graduate from high school, and pursue a STEM career.

Another policy implication is many district administrators do not report the number of SWD who participate in extracurricular activities per the results of RQ2. Perhaps federal policymakers should consider adding the number of SWD to federal reporting for annual yearly progress. Furthermore, federal legislators should consider tying IDEA funding to SWD participation in extracurricular activities, which would force districts to track those numbers. Additionally, state policymakers should consider adding extracurricular participation as a part of the IEP process rather than in the related services, supplementary aids and services section of the IEP. The way the IEP is currently worded regarding extracurricular activities is confusing for educators and parents, which have resulted in lawsuits against districts. For example, in *Independent School District No. 12, Centennial, v. Minnesota Department of Education* the Minnesota Supreme Court refused to limit extracurricular and nonacademic activities to those that “educate the child”. The Court upheld the student’s right to participate in activities as determined by the IEP team through supplementary aids and services.

Once the number of SWD who participate in extracurricular activities can be tracked, researchers should be able to determine the federal category of SWD who participates based on the IEP as noted in RQ3. Moreover, parents need more clarity into what is available to their SWD. The state and districts should consider providing educational resources to parents and special educators for clarification of the law regarding extracurricular activities and SWD.

Another policy implication is funding of extracurricular activities for SWD. Policymakers should be advised to incorporate a practice called "reverse inclusion," whereby after school clubs are created and funded for SWD but all students are encouraged to participate. Additionally, IDEA funding could be used to pay additional stipends to teachers, both special and general STEM educators to stay after school to sponsor these clubs. Stipends for STEM activities should be in line with stipends paid to athletic coaches, and directors of after school arts programs (i.e. band, chorus, drama).

for Research

The relationship between STEM programs and SWD are rarely researched. To address persistent issues and assist in providing helpful skills and tools to educators working with SWD, it is recommended that current interventions and best practices focus on including more SWD in STEM activities. Oftentimes researchers analyze interventions for SWD; however, as addressed in research question two, many school personnel do not track or report the number of SWD who participate in STEM activities. Therefore, it is difficult to effectively research SWD and STEM activities as an intervention. The researcher recommended, for large national studies, that scientists collect data on SWD who participate in STEM activities. Once this data is gathered, researchers will be able to look more closely at trends and issues of SWD and informal science learning. Finally, previous researchers discuss the positive attributes associated with participating in extracurricular activities (Durlak et al., 2010; Fredricks & Eccles, 2008). To include SWD in research on extracurricular activities, unique data collection methods must be used to ensure SWD needs are represented in the literature.

Limitations

As with any study, limitations arise that affect the outcomes of the research. The first limitation is the study was limited geographically to public schools within the state of Florida. According to NCES (2016), there were about 13,500 public school districts in 2012-2013 (N = 13,515, M = 265) with a range of 1,029 districts in Texas and one district in Washington, DC and Hawaii. By comparison, Florida had 67 school districts in 2013 which is much lower than average and could have influenced the data in the current study. Additionally, the 50 states served over 50 million students (N = 50,044,522, M = 981,265) with a range of 6,312,623 in California and 78,153 students in Washington, DC in the fall of 2013 (NCES, 2016). By comparison, Florida served 2,720,744 students in its 67 districts. As a result, Florida is the 4th largest state in terms of student population, however the number of districts that serve the students is lower than most states. In 2015-2016, FLDOE reported 2,792,235 (M = 37,733) students were served by 75 school districts. The range of students per district was 357,579 students in Dade to 484 students in the Florida Agricultural and Mechanical University (FAMU)

Lab School. The diversity and range of the number of students served per district is a variable that was not controlled for and is a limitation in the current study.

The study was limited to student performance data from the districts for the year 2015. Additionally, the data was self-reported to the state by school personnel. Some of the data used in this study were collected using a researcher created survey instrument. Findings are based on the assumptions that the participants responded honestly and interpreted the instrument as intended. Additonally, results could be biased by the personality traits of school personnel who responded to the questionnaire compared to the traits of personnel who deleted the questionnaire without answering or forwarding it.

After-school programs in each district and even each school varies and there is no district or state measurement of the number or types of after-school programs offered. As a result, the researcher utilized an electronic survey to ask school personnel about the types of STEM activities offered in their school district. The answers varied widely depending on the title of the respondent and whether he or she represented a school or district. As a result, these differences may have been a factor in this study with regards to the number of activities offered in a district as well as the reliability of consistency in responses from the survey. Having a reliability of consistency in responses of less than 80% is another limitation as the reliability of the survey was weak. More research should be conducted on the psychometrics of the survey and the variability of participant responses.

When computing both the *t* test and the Pearson's correlation coefficient, the assumption of independence was not met as the sample was not randomly assigned to groups. Furthermore, the assumption of normality was violated for the mean science scores and visual analysis for linearity was weak. Consequently, the internal validity of the test was compromised and impacted the robustness of the results. The probability of a Type I or Type II error may increase as a result of the assumption not being met (Zimmerman, 1997). Because power was greater than the alpha of .05 in the correlation analysis, there is an indication that the null hypothesis of no correlation cannot be rejected. Even with a small positive correlation coefficient, there is a chance the correlation does not exist. Lastly, researcher bias is presumable due to the fact that the researcher holds prior beliefs regarding the influence of STEM activities on SWD due to her experience as a FIRST robotics coach. The study was limited to interpretations made by the author; other plausible explanations may exist.

Future Research

In moving forward, the researcher has identified several directions for future research on SWD and STEM activities. The current study should be addressed again to address limitations. The current study questioned the relationship between the number of STEM activities a district offers and SWD performance on the 2015 8^{th} Grade Florida Science Assessment. Having found a correlation does exist, it would be interesting to know more about factors influencing SWD decision to participate in STEM activities. The focus of the current study was on the 8^{th} grade level. A similar study focusing on the high school level of science and mathematics outcomes and STEM activities could prove interesting. A qualitative study of individual SWD and their perception of STEM activities would be interesting to see if student performance was improved with individual student outcomes. The researcher found PISA scores are disaggregated by type of extracurricular activities. Those scores can be analyzed to determine the impact of extracurricular activities on academics on an international level.

To control for variability across districts, data from the current research can be used to determine which district had the highest activities (Orange) and following up in that district to find out why they offer more activities than other districts. Additional analysis should be conducted on the number of activities and the number of students per district. Another variable that should be controlled is the experience and qualifications of the teachers of SWD in each district as well as the sponsors of the extracurricular activities. Lastly, future research could look into individual activities offered like FIRST robotics or Science Olympiad. With so many activities to choose from, stakeholders might find interesting the STEM activities that impact student outcomes the most.

Conclusion

In the current study, the researcher examined the difference between students with and without disabilities on the 8th Grade Florida Science assessment along with the school personnel report of percentage and disability type as participating in after-school STEM activities. Lastly, the researcher examined the relationship between the number of STEM activities a district offers and SWD achievement on the 8th Grade Florida Statewide Science Assessment. While the focus of most research in the area of informal science learning is geared toward all students, SWD continue to lag behind their peers in science. Consequently, only 5% of the STEM workforce consists of individuals with disabilities (Leddy, 2010). Indeed, more research to add to the literature base about SWD and their participation in extracurricular activities is essential. In fact, it may help close the achievement gap in science for SWD.

In the current study, the researcher determined a statistically significant difference exists between students with and without disabilities on the 2015 8th Grade Florida Science Assessment which addressed the need for the study. Furthermore, the researcher found many districts do not gather or report data on the number of SWD who participate in extracurricular activities and students with learning disabilities are more likely to join extracurricular activities than other types of disabilities. Lastly, the researcher found a small correlation between the number of activities a district offers and the performance of SWD on the 8th Grade Florida Science Assessment.

APPENDIX A: INSTITUTIONAL REVIEW BOARD

APPENDIX A: INFORMED CONSENT LETTER

Version 1.0 10-21-2009

University of Central Florida

EXPLANATION OF RESEARCH

Title of Project: Science, Technology, Engineering, and Mathematics (STEM) Education in Florida Schools.

Principal Investigator: Matthew Marino, PhD

Other Investigators: Karin Fisher, Doctoral Student

You are being invited to take part in a research study. Whether you take part is up to you.

The purpose of this research is to determine the extent of STEM programming in Florida public schools.

Participants will be asked to complete an online questionnaire about STEM programming.

The survey is designed to help improve STEM education. It will take about 7 minutes to complete. The results may be published or presented at conferences. Personally identifiable information will not be published or shared outside of the research team.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, Dr. Marino Associate Professor, College of Education and Human Performance by e-mail at matthew.marino@ucf.edu or Karin Fisher, Doctoral Student at kfisher0915@knights.ucf.edu

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

APPENDIX B: APPROVAL OF EXEMPT HUMAN RESEACH

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University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Matthew Todd Marino** and Co-PIs: **Eleazar Vasquez, Karin Fisher**

Date: **August 13, 2015**

Dear Researcher:

On 08/13/2015, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Addition of Co-investigator: Eleazar Vasquez
Project Title:	Science, Technology, Education, and Mathematics (STEM) Education in Florida Schools.
Investigator:	Matthew Todd Marino
IRB Number:	SBE-15-11355
Funding Agency:	
Grant Title:	
Research ID:	n/a

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 08/13/2015 03:03:15 PM EDT

IRB Coordinator

APPENDIX C: CURRENT FUNDED PROJECTS

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Table 28. IES Current Funded Projects

Title	PI	Institution	Construct	Dates	Award
Boston Public Schools Expanded Learning Time Research Collaborative	Kelly Hallberg	American Institutes for Research (AIR)	Extended learning time, student outcomes	8/1/15-7/31/17	$397,278
Center on Standards, Alignment, Instruction and Learning (C-SAIL)	Andrew Porter	University of Pennsylvania	College and Career Standards, student outcomes, annual student assessments	7/1/15-6/30/20	$9,999,999
Improving Content-Area Literacy Instruction in Middle Schools (Project CALI)	Jade Wexler	University of Maryland, College Park	Middle school, literacy outcomes	7/1/15-6/30/18	$1,500,000
Paths 2 the Future: Testing the Efficacy of a Career Development Intervention for High School Girls with Disabilities	Lauren Lindstrom,	University of Oregon	Education and career outcomes, high incidence disabilities in high school	7/1/15-6/30/19	$3,499,674

Assessing Self-Determination in the Era of Evidence-Based Practices: The Development and Validation of Student and Adult Measures of Self-Determination	Michael Wehmeyer	University of Kansas Center for Research, Inc.	Self-determination, students ages 13-22	7/1/13-6/30/17	$1,589,610
Parent Connectors: An Efficacy Study of Peer-Support for Parents of Middle School Youth with Emotional Disturbance	Kristen Duppong Hurley	University of Nebraska, Lincoln	Middle school students with emotional and behavioral disorders, community based mental health services	7/1/13-6/30/17	$3,206,013
Developing Enhanced Assessment Tools for Capturing Students' Procedural Skills and Conceptual Understanding in Math	Brian Bottge	University of Kentucky Research Foundation	Middle School Students, Math, Self-Contained Math classes	7/1/15-6/30/19	$1,599,999
Using Multimedia to Improve Middle School Science and Special Education Teachers' Use of Evidence Based Vocabulary	Michael Kennedy	University of Virginia	Middle School Science, Special education, Professional Development	7/1/13-6/30/17	$399,974

Practices, and the Impact of Vocabulary Performance of Students with Disabilities					
Science Learning Difficulties: Patterns and Predictions in a Nationally Representative Cohort	Paul Morgan	Pennsylvania State University	Elementary and middle school, science, from Early Childhood Longitudinal Study, Kindergarten Cohort to determine factors most relevant to predict science learning difficulties	7/1/15-6/30/17	$700,000
Predictors of Intermediate and Postsecondary Outcomes for Students with Disabilities	Dan Goldhaber	American Institutes for Research	High school, enrollment in vocational education and inclusion were examined	7/1/15-6/30/17	$806,405

Table 29. NSF Current Funded Projects

Title	PI	Institution	Construct	Dates	Award
Self-Regulation of Science Learning in the Context of Educational Game Creation: A Study of Middle School Students with Learning Disabilities	Sheri Berkeley	George Mason University	Middle school science, learning disabilities	9/1/14-8/31/17	$824,863
Reducing Racial and Gender Achievement Gaps in STEM: Use of Natural Language Processing to Understand Why Affirmation Interventions Improve Performance	Valerie Purdie-Vaughns	Columbia University	STEM, achievement gap, SWD, interventions	9/1/14-8/31/17	$1,035,994
Ramping Up Accessibility in STEM: Inclusively Designed Simulations for Diverse Learners	Emily Moore	University of Colorado at Boulder	Interactive science simulations for middle school students with disabilities	7/15/15-6/30/17	$449,186
Collaborative	Overtoun	Auburn	STEM,	10/1/09-	

Research: Alabama Alliance for Students with Disabilities in STEM	Jenda	University	Students with Disabilities	9/30/16	
Pacific Alliance for Supporting Individuals with Disabilities in STEM Fields partnership (Pacific Alliance)	Robert Stodden	University of Hawaii	STEM, Students with Disabilities	10/1/09 – 9/30/16	
Collaborative Research: STEM Education and Workforce Participation over the Life Cycle: The Intersection of Race, Ethnicity, Gender, and Disability Status	Eric Grodscky	University of Wisconsin - Madison	STEM, High School	8/15/14 – 7/31/17	$194,085
Collaborative Research: Georgia STEM Accessibility Alliance (GSAA)	Robert Todd	Georgia Tech Research Corporation	STEM, postsecondary enrollment	10/1/10 – 9/30/17	$1,639,344
Building an Alliance for New Careers in STEM (KC-BANCS): A Collaborative Model for the Inclusion of Youth and Veterans with	Ronda Jenson	University of Missouri – Kansas City	High School, STEM persistence	10/1/09 – 9/30/16	

Disabilities					
RDE-MB1 Comprehensive Support for STEM Students with Learning Disabilities (CS3LD)	William Mann	University of Florida	STEM, Learning disabilities, Undergraduates	2/1/13 – 1/31/17	$846,000
Building a Unified Research Agenda for K-12 Online Learning Environments to Improve STEM Outcomes for Students with Learning Disabilities and Students with Autism Spectrum Disorders	Ellen Schiller	SRI International	Students with learning disabilities, and ASD, STEM	9/1/14 – 8/31/18	$586,021
Multiple Consciousnesses: Investigating the Identities (Academic, Gender, Race, and Disability) of Black Women Undergraduate Students in STEM and their Impact on Persistence	Lorraine Fleming	Howard University	Undergraduate black women in STEM, SWD	9/15/15 – 8/31/20	$1,399,223
Ramping Up Accessibility in STEM: Inclusively	Emily Moore	University of Colorado at Boulder	Simulations to teach K-12 STEM to Students with	7/15/15 – 6/30/17	$449,186

Designed Simulations for Diverse Learners			and without disabilities		
Collaborative Research: STEM Education Effects on a Diverse Workforce’s Development over the Life Cycle	John Warren	University of Minnesota – Twin Cities	STEM skills and training acquired during high school	10/1/13 – 9/30/18	$257,245
Collaborative Research: STEM Education Effects on a Diverse Workforce’s Development over the Life Cycle	Chandra Muller	University of Texas at Austin	STEM skills and training acquired during high school	10/1/13 – 9/30/18	$1,618,421
Collaborative Research: A study of Interactional, Organizational, and Professional Mechanisms of Disadvantage in the Underrepresented and Marginalized STEM Workforce	Tom Waidzunas	Temple University	Barriers to entry into STEM workforce,	9/15/15 – 8/31/18	$99,771
Collaborative Research: A study of Interactional, Organizational,	Erin Cech	William March Rice University	Barriers to entry into STEM workforce,	9/15/15 – 8/31/18	$222,361

and Professional
Mechanisms of
Disadvantage in
the
Underrepresented
and Marginalized
STEM
Workforce

Table 30. Publications from the IES and NSF grants

Reference	Target Skill	Intervention	Design	Disability Category	Participant Information	Findings	Relevant Component(s)
Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma (2015)	Math, fraction computation and problem solving skills	Enhanced anchor instruction	Mixed method	Mild mental disability, other health impaired, SLD, autism, EBD	Middle school students in inclusive classrooms	Enhanced anchor instruction scored statistically significant higher than control group = Effect size 1.15	Math, middle school
Bottge, Ma, Gassaway, Toland, Butler, & Cho (2014)	Math, fraction computation and problem solving skills	Blending explicit and enhanced anchor instruction	Hierarchical linear model	Mild mental disability, other health impaired, SLD, autism, EBD	Middle school students in math resource classrooms and their teachers	Students taught with enhanced anchor instruction outscored the control on three out of four math measures	Math, middle school students with disabilities

Bottge, Ma, Gassaway, Butler, & Toland (2014)	Math, computation and problem solving	Blended version of Enhanced Anchored Instruction	Hierarchical linear model	Mild mental disability, other health impaired, SLD, autism, EBD	Middle school students with disabilities	Students taught with enhanced anchored instruction reduced their errors	Math, middle school students with disabilities
King-Sears, Johnson, Berkeley, Weiss, Peters-Burton, Evmenova, Menditto, & Hursh (2015)	Chemistry specifically mole conversion	Co teaching using UDL	Pre-Post test and social validity	LD, OHI, SED, Autism	High school students with and without disabilities	No statistically significant difference for all groups, however students with disabilities scored higher in the UDL condition group (effect size = .80)	Science, UDL
Rabren, Carpenter, Dunn, & Carney (2014)	Post school outcomes	Career technical education	Exploratory Factor Analysis - Univariate ANOVA	SLD, ID	Former high school students with SLD or ID	Five variables were significant: gender, race, LRE, job status in high school, and participation in CTE.	SWD, post school outcomes

Rojewski, Lee, & Gregg (2015)	Post school outcomes	Inclusion	Propensity score analysis	LD, EBD	NLTS-2 Data	Significant association between inclusion and post-secondary education outcomes	SWD, inclusion
Lee, Rojewski, Gregg, & Jeong (2014)	Post-secondary Education Persistence	None	Logistic Model	SLD, EBD	Education Longitudinal Study of 2002 – public high school graduates	Grade Point Average, Socioeconomic status and number of friends planning to attend a 4 year college were a significant predictor of educational persistence	SWD, post school persistence
Jenson, Petri, Day, Truman, & Duffy (2010)	Self-Efficacy	none	Focus Group	Speech, visual, ADHD, physical, LD, ASD, psychiatric disorders	Post-secondary students	Faculty and student relationship play an important role	

Wei, Lenz, & Blackorby (2013)	Math Achievement	none	Hierarchical linear modeling	11 disability categories	Elementary and secondary students	Students with speech and visual had highest math achievement, multiple disabilities and intellectual had lowest. SEELS data base	SWD, math achievement
Wei, Yu, Shattuck, McCracken, & Blackorby	STEM participation	none	Logistic Regression	ASD	Postsecondary students	NLTS2 data. Young adults with ASD who attend college are more likely to pursue STEM majors, specifically science and computer science.	ASD, STEM

APPENDIX D: ARTICLES SELECTED FOR ANALYSIS

APPENDIX D: ARTICLES SELECTED FOR ANALYSIS

Table 31. Overview of the Articles Selected for Analysis

Thomson Reuters (ISI) Web of Science	Authors	Methodology described
Assessment for Effective Intervention: Enrichment Science Academic Program	Sasson & Cohen (2013)	Constructivist
Self-Regulated Learning and Instructional Factors in the Scientific Inquiry of Scientifically Gifted Korean Middle School Students	Yoon (2009)	Social Cognition

EBSCO	Authors	Methodology described
The purpose of the study was to determine the extent to which girls interest and confidence in two key STEM development areas, problem solving and creativity and design, predict their interest in STEM subject areas.	Cooper & Haverlo (2013)	Project based learning, project based science, & anchored instruction
The purpose was to examine the way a 12-week after-school science and engineering program affected middle school students' motivation to engage in science and engineering activities	Jones et al., (2015)	Motivation, Engagement
The paper describes the process of translating an existing teacher-led STEM curriculum to fit a learner-led, voluntary learning environment	Newbill, Drape, Schnittka, Baum, & Evans (2015)	Social Constructivism and Problem Based Learning

Investigate the impact of Beyond Blackboards on students’ interest in and understanding of engineering	Blanchard et al., (2015)	Inquiry based
School, Teacher, Peers, and Parents’ Goals Emphases and Adolescents’ Motivation to Learn Science in and out of School.	Vedder-Weiss & Fortus (2013)	Motivation

Science Direct	Authors	Methodology described
Recent advances in research on school-based extracurricular activities and adolescent development	Farb & Matjasko (2012)	Developmental ecological model
Profiles and portfolios of adolescent school-based extracurricular activity participation	Feldman & Matjasko (2007)	Ecological systems theory
Opportunity to participate: Extracurricular activities distribution across and academic correlates in high schools	Stearns & Glennie (2010)	Opportunity structure theory
Vitalizing creative learning in science and technology through extracurricular club: A perspective based on activity theory	Hong, Chen, & Hwang (2013)	Communities of Practice, activity theory

APPENDIX E: E-MAIL SENT TO DISTRICT PERSONNEL

APPENDIX E: E-MAIL SENT TO DISTRICT PERSONNEL

STEM information to collect.

KJ Keener, Jonathan <Jonathan.Keener@fldoe.org>
10/6/2015
Keener, Jonathan <Jonathan.Keener@fldoe.org>; Karin Fisher

Reply all

Marino

You replied on 10/6/2015 1:07 PM.

Action Items

Dearest Science Leadership;
I am hopeful that you can assist me in collecting some data to help drive our initiatives.
The University of Central Florida and the Florida Department of Education are conducting research on the state of STEM professional development (PD).
The purpose of this research is to advance STEM education through improved professional development using data from this research. This electronic survey should take approximately 7 minutes to complete and can be completed on most devices including cell phones. This survey is for leadership and teachers. PLEASE FORWARD to your district to assist us in collecting the information.
Should you have any questions about this research please contact Karin Fisher (kfisher0915@knights.ucf.edu) or Dr. Vasquez (eleazar.vasquez@ucf.edu). Thank you!

http://survey.az1.qualtrics.com/SE/?SID=SV_574yNVVr1895lVb

Thank you in advance

Dr. JP Keener
Director Mathematics, Science and STEM Programs
Bureau of Standards and Instructional Support
Division of Public Schools
Florida Department of Education
850-245-0808
Jonathan.Keener@fldoe.org

Figure 17. E-mail sent to Florida District Personnel

APPENDIX F: SURVEY

APPENDIX F: SURVEY

STEM Education

Q1 This survey is designed to help improve STEM education. It will take about 7 minutes to complete. By checking this box, I consent to participate in the survey. I understand the results may be published or presented at conferences. I also understand that personally identifiable information will be published or shared outside of the research team. Dr. Matthew Marino and colleagues at the University of Central Florida are conducting this research.

- ❍ Yes (1)
- ❍ No (2)

Q2 What is your gender?

- ❍ Male (1)
- ❍ Female (2)

Q3 What is your current position?

- ❍ State STEM Administrator (1)
- ❍ District STEM Administrator (2)
- ❍ School STEM Administrator (3)
- ❍ STEM Teacher (4)
- ❍ Principal (5)
- ❍ Other (6) ____________________

Q4 What district do you represent?

- Alachua (1)
- Baker (2)
- Bay (3)
- Bradford (4)
- Brevard (5)
- Broward (6)
- Calhoun (7)
- Charlotte (8)
- Citrus (9)
- Clay (10)
- Collier (11)
- Columbia (12)
- DeSoto (13)
- Dixie (14)
- Dozier/Okeechobee (15)
- Duval (16)
- Escambia (17)
- Flagler (18)
- FAMU Lab School (19)
- FAU Lab School (20)
- Florida School for the Deaf and Blind (21)
- Florida Virtual School (22)
- Franklin (23)
- Gadsden (24)
- Gilchrist (25)
- Glades (26)
- Gulf (27)
- Hamilton (28)
- Hardee (29)
- Hendry (30)
- Hernando (31)
- Highlands (32)
- Hillsborough (33)
- Holmes (34)
- Indian River (35)

- Jackson (36)
- Jefferson (37)
- Lafayette (38)
- Lake (39)
- Lee (40)
- Leon (41)
- Levy (42)
- Liberty (43)
- Madison (44)
- Manatee (45)
- Marion (46)
- Martin (47)
- Miami-Dade (48)
- Monroe (49)
- Nassau (50)
- Okaloosa (51)
- Okeechobee (52)
- Orange (53)
- Osceola (54)
- Palm Beach (55)
- Pasco (56)
- Pinellas (57)
- Polk (58)
- Putnam (59)
- St. Johns (60)
- St. Lucie (61)
- Santa Rosa (62)
- Sarasota (63)
- Seminole (64)
- Sumter (65)
- Suwannee (66)
- Taylor (67)
- Union (68)
- UF Lab School (69)
- Volusia (70)
- Wakulla (71)

- Walton (72)
- Washington (73)
- Other (74)

Q5 What type of STEM professional development is currently offered in your district?

- Online modules related to content (1)
- District led (e.g., professional development days dedicated to STEM) (2)
- Professional development at a central location including multiple counties (e.g., local university) (3)
- Professional STEM learning groups (4)
- Online modules related to assessment (5)
- Money for STEM teachers to attend professional development (6)
- Other (7) ____________________

Q6 How many hours of STEM professional development did your district provide this year for each STEM teacher?

- None (1)
- 1-5 hours (2)
- 5-10 hours (3)
- 10 or more hours (4)
- I am not sure (5)

Q7 How many hours did you participate in STEM professional development this year?

- None (1)
- 1-5 hours (2)
- 5-10 hours (3)
- 10 hours or more (4)

Q8 At what grade level are students first introduced to STEM as a career choice?

- ❍ K - 3 (1)
- ❍ 4 - 6 (2)
- ❍ 7 - 8 (3)
- ❍ 9 - 12 (4)
- ❍ Not sure (5)

Q9 What types of activities does your school or district offer to promote STEM?

- ❍ Science Fair (1)
- ❍ FIRST Robotics (2)
- ❍ Common STEM planning time (3)
- ❍ Thematic STEM assignments (4)
- ❍ Modeling and Simulation Club (5)
- ❍ SECME (6)
- ❍ Other STEM club (7) ____________________

Q10 What programs in your school or district are specifically designed to promote the inclusion of students with disabilities in STEM activities?

- ❍ We do not provide any special programs (1)
- ❍ We have a target number of students with disabilities who are recruited for STEM activities (2)
- ❍ Other (3) ____________________

Q11 What group of students with disabilities has the largest representation in STEM activities in your school or district?

- ❍ Learning Disability (1)
- ❍ Autism Spectrum Disorder (2)
- ❍ Other Health Impairment (e.g. ADHD) (3)
- ❍ Other (4) ____________________

Q12 What percentage of students in your STEM clubs are female?

- We do not track the number of females (1)
- 0 - 20% (2)
- 21 - 40% (3)
- 41 - 60% (4)
- Greater than 60% (5)

Q13 What percentage of students in your STEM clubs have a disability?

- We do not track the number of students with a disability in our STEM clubs (1)
- 0 - 20% (2)
- 21 - 40% (3)
- 41 - 60% (4)
- greater than 60% (5)

Q14 At what level are students in your school or district encouraged to pursue STEM careers?

______ Gifted Students (1)

______ Students in College Prep Courses (2)

______ Female Students (3)

______ English Learning Students (4)

______ Average Students (5)

______ Students with Disabilities (6)

Q15 At what level has your district adopted Universal Design for Learning (UDL) as a way to enhance STEM learning and assessment?

______ UDL adoption (1)

Q16 Please rate the degree to which the following items affect your ability to enhance STEM learning opportunities for students with disabilities.

______ Teacher Knowledge (1)

______ Teacher Skills (2)

______ Time (3)

______ Money (4)

______ Available Technology (5)

Q17 How do you feel your district can improve STEM education for students?

Q18 How do you feel your district can improve STEM education for teachers?

Q19 Have you participated in the Lockheed Martin/UCF Academy?

❍ Yes (1)
❍ No (2)

Q20 Are you interested in learning more about the Lockheed Martin / UCF Academy and its funding opportunities? If yes, please enter your email below.

- ❍ Yes (1) ____________________
- ❍ No (2)

Q21 If you would like to receive a copy of the report from this survey please enter your email address below. Thank you!

- ❍ Please email my report to: (1) ____________________

APPENDIX G: NUMBER OF ACTIVITIES OFFERED PER DISTRICT

APPENDIX G: NUMBER OF ACTIVITIES OFFERED PER DISTRICT

Table 32. Number of Activities offered per district

Florida District	Number of Activities
Alachua	6
Baker	1
Bay	2
Bradford	2
Brevard	7
Broward	10
Calhoun	0
Charlotte	5
Citrus	1
Clay	6
Collier	3
Columbia	4
DeSoto	0
Dixie	0
Okeechobee	0

Duval	1
Escambia	0
Flagler	3
FAMU Lab School	0
FAU Lab School	5
Florida School for the Deaf and Blind	0
Florida Virtual School	1
Franklin	0
Gadsden	0
Gilchrist	0
Glades	0
Gulf	0
Hamilton	0
Hardee	1
Hendry	0
Hernando	0
Highlands	0
Hillsborough	9
Holmes	3
Indian River	0
Jackson	0

Jefferson	0
Lafayette	1
Lake	0
Lee	0
Leon	4
Levy	0
Liberty	0
Madison	1
Manatee	1
Marion	0
Martin	0
Miami Dade	5
Monroe	0
Nassau	4
Okaloosa	0
Okeechobee	3
Orange	17
Osceola	9
Palm Beach	14
Pasco	0
Pinellas	2

Polk	0
Putnam	0
St. Johns	0
St. Lucie	11
Santa Rosa	8
Sarasota	3
Seminole	12
Sumter	0
Suwannee	2
Taylor	2
Union	5
UF Lab School	0
Volusia	9
Wakulla	0
Walton	0
Washington	1
Other	2

APPENDIX H: STEM ACTIVITIES TYPED IN OTHER

APPENDIX H: STEM ACTIVITIES TYPED IN OTHER

Table 33. STEM Activities Typed in Other

Other STEM club	TSA
Robotics	Robotics Club
VEX Robotics	STEM Club
FJAS	Ecology Club
STEM Club	TSA
the county does not offer anything but we do BEST robotics and Science Olympiad, as well as Small Basic, and Gaggle suite activities.	VEX Robotics
HS Science Club	TSA
Nothing	Chipola College STEM Days
Robotics	TSA
Migrant STEM After-school program Grades 6-8	VEX robotics
4H	MathCounts
Forensics Class	Project Lead the Way
4-H Club	TSA
Computer Science/Coding	IDK
HOSA	astronaut challenge
Coding	Odyssey of the Mind
VEX robotics	STEM Classes
First Lego League Robotics	BEST Robotics
WeatherSTEM	Robotics
Robotics - integrated into instructional day	Other STEM Club
Coding Club	Math team
Elementary Science Club	PLTW
Science	Envirothon, Chemathon
Science Club	Green Roof Team

Technology	Design Challenges, Solar Car Designs, Science Olympics
Gifted Enrichment on Fridays	Robotics
STEM Activities Typed in Other	
Astronomy	MS and HS STEM Clubs - Robotic, Electric car races...
Science Club	Gifted teachers teach STEM to each class for 1 hr. every 4-6 wks.
Grade level STEM activities each month	STEAM Days
STEM Classes	Project Lead the Way
Robotics (not FIRST)	Math Counts
Science Bowl	T.E.A.M.S.
Math-letics	RaspberryPi
Engineering Internships	Math Olympiad
Lab Days	Video Game Club
After-school STEM Club	HOSA
Science Club	microgravity
Coding	STEM Elective
Engineering Club	After-school migrant tutorial
T. S.A.	Robotic elective

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