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How Does Executive Function Skills Instruction Impact Student Executive Function Levels And Academic Achievement On Common Core State Standards Assessments?

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HOW DOES EXECUTIVE FUNCTION SKILLS INSTRUCTION IMPACT STUDENT EXECUTIVE FUNCTION LEVELS AND ACADEMIC ACHIEVEMENT ON COMMON CORE STATE STANDARDS ASSESSMENTS?

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ABSTRACT

Executive function skills are vitally important to student success in school and later in life. Executive function skills can and are improved with specific skills instruction. The literature reveals a correlation between executive function and academic achievement. So, the theory proposed is that raising executive function levels will raise achievement levels. The role of executive function in student achievement in the Common Core State Standards was studied with a fourth grade class. It was conducted over a nine-week period, and used an experimental and control group. Both groups were given an executive function pretest and academic achievement (Common Core) pretest. During the treatment period, the experimental group was given explicit executive function skills instruction in the form of the Pomodoro Technique. This technique addressed the following executive functions: managing time, using visual organizers, planning transitions, creating to-do lists, recording and reflecting on data, self-regulation, and reducing working memory load. This technique was implemented daily. At the end of the nine week period, both groups were given executive function and achievement posttests. The statistical analysis revealed that the experimental group's executive function level improved significantly compared to the control group.

DEDICATION

This dissertation is dedicated to my husband, Grant and children, Dylan, Evan, Georgia, and Rhett who sacrificed time, loved, and supported me throughout. I dedicate this dissertation to my sister, Jalane, for encouragement and keeping my feet on the ground. Further, I dedicate this dissertation to my mother, Gwen, for believing in me, encouraging me, and calming me down when I was stressed out. Finally, this dissertation is dedicated to my grandmother, Stella Renfrow, a great woman who taught me how to see the good in people and the world.

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CHAPTER 1

Introduction

The uniquely human ability to plan, manage time, inhibit responses, and persist toward future goals is what separates humans from other species. These abilities vary significantly from person to person; based on maturity, socioeconomic status, health, and stress level. Students enter school with a certain potential for developing executive functions, but the above-mentioned factors among others can impact students' ability to achieve academic success to their potential. The research reveals that certain strategies can impact executive function development. Therefore, supporting student executive function development should be a priority for educators as well as parents (Kaufman, 2010).

Statement of the Problem

For decades, researchers have explored the causes of and treatments for executive dysfunction in various populations to glean information about how executive function works. Baddeley (1987) discovered many layers and components to executive function and its relation to the other functions of the brain. Researchers have tested how these components relate to each other and how they impact intelligence; however, research exploring the impact of the effects of executive function deficits of students engaged in the Common Core State Standards (CCSS) on achievement has not been undertaken. This lack of research makes the proposed study designed to target affects of executive function skills instruction in elementary students both relevant and timely.

Purpose of the study

The purpose of this study was to investigate how executive function skills instruction affects middle school students' (those with disabilities and without) success in meeting the Common Core State Standards. Executive functions are those skills, generally housed in the prefrontal cortex of the brain, that enable learners to use all other parts of the brain to perform complex mental tasks, such as planning, task shifting, and inhibition behaviors (Mahone & Hoffman, 2007). Executive function skills instruction for the purpose of this study consisted of a study curriculum known as the Pomodoro Technique. This curriculum included practice in many executive function skills such as: planning, self-regulation, and metacognition.

Executive function skills are vitally important to the academic success of students (Singer & Bashir, 1999). In a 2009 study, Alloway revealed a correlation between executive function levels and academic performance. This study followed a 2006 study of the association of executive function and achievement of students with low socio-economic levels in which Waber, Gerber, Wagner, Forbes, and Turcios found that 30 to 40 percent of the variance in test scores was due to executive function in math and English. This link makes executive function an area of concern for educators and parents, as well as potential employers who desire organized, responsible employees who are able to think critically and solve problems.

The proposed study explored the role of executive function in student achievement related to the CCSS. This research determined if connections between executive function and achievement were evident while providing important data on the relationship between executive function and student success in meeting the Common Core State Standards.

Student achievement of the curriculum is not only a legal requirement (The Elementary

and Secondary Education Act, n.d.), but also an ethical one of high stakes for the student with executive function deficits. Students who are unsuccessful in the curriculum are at risk of not graduating from school. It is important to explore how executive function skills instruction affects student academic success, because these skills predict many important life outcomes for children later in life; outcomes such as income level, physical wellness, and general life quality (Diamond, 2013).

Research Questions

Despite the magnitude of this subject, little was known about whether varying levels of executive function inherent in today's classrooms impact students' mastery of the Common Core State Standards, or whether executive function skills instruction can improve executive function or increase academic achievement. This study was crafted to provide information to educators and parents about this topic, and generate useful data that empowered educators to deliver appropriate instruction that adequately meets the needs of all their students. The research question that drives this study was: How do specific executive function interventions affect 4th grade students' executive function and academic success in meeting Common Core State Standards? A student's executive function level was a concern because of the long-term implications of its effect on academic and social outcomes. For example, in Western culture, people whose executive functioning was highest were ranked near the top in academic and social hierarchies (St. Clair - Thompson & Gathercole, 2006). Students should have the opportunity to develop executive functioning skills while in school so they will be prepared for demands brought on by careers in their future.

In an effort to ensure student preparedness, there has been an increasing interest in ways for educators to demonstrate accountability. This interest led to legislation which ensured

teachers focus on standardized testing of achievement (Assaf, 2008). More recently, many states have adopted the Common Core State Standards (CCSS) to increase rigor and better prepare students for jobs in a global marketplace. This study sought to determine if an emphasis on executive functioning skills instruction was a valuable time investment in raising executive functioning levels and achievement levels of students in the Common Core State Standards.

There was a void in the literature of studies that address how specific executive function skills instruction impacts both the executive function levels and the academic success needed to meet the rigor inherent in the standards. This proposed quasi-experimental study sought to determine whether the executive function level of a student had an impact on the students' academic success given the increased rigor and high executive function demands of the CCSS. It would seem that students with higher executive function skills would experience a higher level of success, so determining whether executive function skills instruction will increase student executive function level and thus impact achievement in meeting the CCSS was the focus of this study.

The questions addressed in this study were:

1. Is there a significant difference in the academic achievement between the experimental group and the control group?
2. Is there a significant difference in the executive function levels between the experimental group and the control group?
3. Is there a significant difference between the executive function levels between the pretest and posttest of both groups?
4. Is there a significant difference between the academic achievement (as evidenced by common assessment scores) between the pretest and posttest of both groups?

5. Is there a correlation between the academic achievement and executive function level based on executive function and common assessment posttests of both groups?

Terms and definitions

1. Executive Function - Cognitive processes that enable one to plan, initiate and inhibit behaviors, switch from one task to another and regulate one-self (Diamond, 2013).
2. Attention Deficit Hyperactivity Disorder - ADHD "A persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequently displayed and more severe than is typically observed in individuals at a comparable level of development" (Diagnostic and statistical manual of mental disorders, 2000, p. 85).
3. Impulsivity - The tendency of a person to act prior to thinking things through (McLeskey, Rosenberg & Westling, 2013).
4. Working Memory - The ability to temporarily hold information in the mind and use it (McLeskey, Rosenberg & Westling, 2013).
5. Self-control - The ability to resist doing things or acting impulsively (Diamond, 2013).
6. Cognitive flexibility - The ability to switch between tasks or adjust to new situations (Diamond, 2013).

Limitations

1. The results of this study may not be generalizable to all age groups because of the unique characteristics of brain development and maturation level of this age student.
2. A causal relationship will not be made regarding the findings of this study. This study only serves to discover if a relationship exists. It is impossible to rule out all other reasons for the results.

3. The subjects of this study are limited to one, fourth grade class in a rural Mississippi public school, during the 2014-15 school year. This small sample size might limit the ability to make generalizations about the results.
4. The experimental group will be instructed in the morning each day, and the control group will be instructed in the afternoon, due to scheduling constraints of the school.
5. The study will be limited to one nine-week grading period.
6. The teacher will be initially trained in the weeks preceding the treatment, and will not be experienced with using the treatment prior to the treatment period.
7. It is assumed that the control group will not be exposed to or use the treatment during the treatment period.

For these reasons, this may be considered a preliminary study and based on findings, future studies might include changes such as: expanding the sample size and lengthening the treatment period.

Delimitations

1. This study was delimited to 50 fourth grade students in rural Mississippi who have been taught using curriculum to address the Common Core State Standards for at least three years. Twenty-five students will be part of the experimental group and will receive specific training to develop executive function skills. Twenty-five students will be part of the control group and will not receive the executive function skills training. All students will have instruction from the same teacher.
2. Executive function was assessed using the Trail Making Test (TMT), a test designed to ascertain executive function levels.

3. The morning group was selected as the experimental group and the afternoon group as the control.

At the conclusion of the study, if results are favorable, the teacher will give the control group the opportunity to study and use the Pomodoro Technique in class.

Organization of the study

This study was structured into five chapters. In the first chapter, the introduction provides readers with an overview of the study including such topics as the research question, statement of the problem, limitations and delimitations, significance of the study, key terms and definitions, followed by the organization of the study. In chapter two, the reader is provided an introduction to current literature germane to the study including theoretical background, overview and characteristics of executive dysfunction, tests of executive function, environmental influences, and interventions and links to the Common Core Curriculum each of which forms the foundation of the study. Relevant research projects will also be highlighted. Finally, this chapter concludes with a brief summary designed to synthesize the information.

In chapter three, the reader is provided with the design and context of the study, descriptions of the participants and the instruments that will be used to gather information. An outline will detail the procedures that will be used to carry out the study and provide an explanation of the data analysis. This chapter is concluded with a brief summary also.

In chapter four, the resulting data gathered will be cataloged both in narrative and table form. The reader will find raw data as well as the results of the statistical analysis. The data will be organized by each hypothesis and reveal if each hypothesis was rejected or not. The information will be summarized briefly.

Finally, chapter five will include a conclusion and analysis of the study. This is the most important chapter of the dissertation. In this chapter, the reader will find the answer to the research question, an analysis of how the results fit into the current body of knowledge, and what the results mean to educators.

CHAPTER 2

Literature Review

Introduction

One of the most significant discussions in education today focuses on ensuring student academic mastery of the standards. The Common Core State Standards (CCSS) promise to have a powerful influence on instruction. The standards and their accompanying instructional strategies have the potential to substantially increase student achievement. This literature review will focus on some of the factors that contribute to student achievement. These factors include: standards-based accountability, curriculum and instruction, student developmental issues/disabilities, executive function, and finally interventions designed to support struggling learners. Although the literature presents these issues as they apply to all ages and ability ranges, this paper focuses primarily on their application to upper elementary students; both those with disabilities (executive dysfunctions) and without disabilities who are engaged in the CCSS.

State of Accountability in the Nation

In 2002, No Child Left Behind required that all students regardless of their disability be tested with high-stakes tests. These tests were designed to determine if students are making "adequate yearly progress toward" academic success (Aron & Loprest, 2012). In 2010, the Obama administration outlined in a blueprint its priorities for reform of No Child Left Behind (NCLB). The goals are to make sure that every child is educated by a first-rate teacher who is led

by a first-rate principal, to furnish families with data that will allow them and teachers to enhance learning, to institute college and career ready standards, and to provide intensive interventions to failing schools. The goal was that every student should be ready for college or career upon graduation from high school, regardless of his/her disability, racial background, or socio-economic status. Further, new assessments were designed to ascertain student readiness for college or career endeavors. The president calls for an educational system that is well-rounded and helps students become contributing members of society.

The Obama administration believes that the accountability standards should be rigorous, but also fair to students at all levels. Accountability is encouraged by using resources to meet the needs of diverse learners, including those with disabilities. Race to the Top (RTT) is a reform initiative designed to encourage school success by implementing rigorous standards and improved assessments, informing stakeholders of student progress through updated data systems, supporting educators' efficacy, and implementing data supported interventions to improve low-performing schools (Race to the Top, n.d.). The blueprint continues to support the reforms incentivized by RTT (Duncan & Martin, n.d.).

Educational accountability was defined as the product of an education. As educators identify goals, (e.g. increased rigor, qualified teachers, or adherence to special education mandates) they must decide how to measure the goal to see if it has been met (Thurlow, n.d.). In *The Accountability Plateau,* Mark Schneider (2011) suggests that although significant improvements in the American students' math performance was achieved through the accountability model of NCLB, the data shows that the boost was short lived, and the increases once seen in math have plateaued. Schneider argues that another major change is necessary to

produce another boost in performance. The national debate regarding the state of accountability has been invigorated with the release of National Assessment of Educational Progress (NAEP) scores. In the last decade, the student performance scores have spurred states to revisit accountability and the reauthorization of the Elementary and Secondary Education Act ESEA/ NCLB to find a solution.

Texas was one of the pioneer states in the nation to establish a new stringent and consequential model of accountability. When looking at the NAEP scores for Texas since its new accountability model was implemented a trend can be revealed that may give insight to the state of student performance across the nation. In the year before the Texas system of accountability was implemented, Texas was on the same level as the nation in fourth grade math. After implementation, the fourth grade Texans had outperformed their counterparts across the nation in growth. By 1996, many other states had enacted their own accountability models and consequently all math scores improved. By the time the entire nation had enacted stricter accountability models, the nation began to catch up to the performance of the Texas fourth graders in math, and in 2011 no significant differences were observed in the scores. The most informative data however, is the relationship between the score of subgroups in Texas and those of the nation. Low performing students who scored at about the 10th percentile, black students, and Hispanic students scores improved faster than those of their national counterparts, but again, as the scores increased a plateau was eventually reached. The same cannot be said about eighth grade Texans in the area of math. Although their initial scores fell below that of the national average before accountability, their scores showed steady increases and no plateau was seen (Schneider, 2011).

Critics argue that the stricter accountability systems we have in place with NCLB put such an emphasis on the low-performing and sub-groups of black and Hispanic groups that the high-performing students were neglected. The data from the Texas NAEP scores does not seem to support that idea. It is worth noting that whenever the emphasis is placed on a subgroup, the high performing groups scores improved as well (Schneider, 2011).

As impressive as the gains in math for Texas and the nation as a whole have been, the reading gains have been relatively flat. There has essentially been no change in the performance of students in the area of reading, according to the NAEP scores. This absence of improvement is cause for concern for educators and coupled with the plateauing of math scores leads Schneider to suggest another upset in the nation's accountability system is in order (Schneider, 2011).

In 2011, a group of 156 organizations released a statement on NCLB. They indicated that they supported the efforts of NCLB to close the achievement gap and raise academic achievement for all students. Further, they are in agreement with the government that an accountability system must be in place to encourage and help students without regard to their race, socio-economic status, disability status, or language proficiency level to become participating citizens. They expressed concerns and offered these and other recommendations for NCLB, that the law should: 1. enact achievement targets that are in line with those of highly effective schools, 2. measure a student's progress based on his/her growth in conjunction with performance to determine proficiency, 3. use multiple and varied indicators of achievement; 4. provide funding for research, 5. encourage schools to introduce more school level assessments for more timely information, 6. allow schools to test annually only in certain grades to relieve the assessment responsibility, and 7. make sure schools have enough time to implement plans for school improvement (Home-News, n.d.).

Common Core State Standards

In 2009, representatives from the National Governors Association (NGA) and the Council of Chief State School Officers (CCSO) began development of a set of Common Core State Standards. These standards are intended to increase rigor and standardize the curriculum to allow for children living in any state to move to a new state and know that the schools curricula are aligned and consistent. These standards encourage collaboration between states on issues from materials to assessment and address the concerns of the Forum on Educational Accountability. The NGA and CCSSO developed the CCSS based on the results of surveys, scholarly research, and data analysis. The final set of standards elevate expectations of student learning and deepen student thinking (Achieving the Common Core, n.d).

CCSS were developed by state educational leaders to make certain that all students will enjoy better opportunities and access to their chosen vocation. The adoption of CCSS is an effort to comply with NCLB and prove through accountability models, that all students can graduate from high school with the standard set of skills essential to success in life. This is also a goal of the current administration as outlined in the blueprint. The adoption of the CCSS is a first step in the betterment of our nations schools, so American students can perform on a level similar to that of their peers in the world. This is a critical endeavor for students entering a global economy (Achieving the Common Core, n.d).

In 2011, Porter, McMaken, Hwang, and Yang explored the differences in the Common Core Standards and those of the states. Historically, individual states have independently developed guidelines and curricula to meet individual state's needs. This resulted in diverse and incongruent standards across the nation. The CCSS were the states' answer to this disparity. After being released in 2010, the CCSS were adopted by a majority of states. An investigation into the differences in the CCSS and state standards was conducted in 2011. This study used

Surveys of Enacted Curriculum (SEC) as a method of organizing data at the point of intersection of topics covered and cognitive demands placed by standards for both math and English language arts and reading (ELAR). The study further delved into the alignment of CCSS and NAEP and current state tests.

The researchers examined 217 topics for math and 163 for English, Language Arts and Reading (ELAR), and in the area of cognitive demands 1,085 for math and 815 for ELAR. The data was placed in cells of intersection and ultimately averaged and used to calculate alignment. The results led the researchers to conclude that CCSS is substantial shift from current state standards and assessments. The CCSS are very different from current state standards in both ELAR and math, which was expected since they are also different from each other. But the researchers also found that the CCSS are very different from standards in high performing states like Massachusetts and other countries with superior performing students. Current standards in these institutions place a greater emphasis on performing procedures, while CCSS emphasizes greater executive function skills or higher cognitive demand. The researchers remain undecided as to whether the CCSS are a better choice than current state standards; they suggest that the support of the many states that have adopted the CCSS and a uniform assessment from only two assessment groups instead of 50 will only improve student learning. The cognitive (executive function) demand placed on students in the CCSS is higher than that of the current state standards, but CCSS has less focus than current standards as a whole (Porter, McMaken, Hwang & Yang, 2011).

The Regional Educational Laboratory (REL) studied the plans of the Southeastern Region states to adopt and implement the CCSS. Using a questionnaire, the researchers discovered that the six states in the Southeastern Region (Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina) adopted the CCSS after a review of the

standards by educators. Florida and Mississippi began using the CCSS in the 2011-12 school year in grades K-2. Alabama, Georgia, and North Carolina began using the CCSS in the 2012-13 school year, with South Carolina beginning in the 2013-14 school year with full implementation. All the six Southeastern Region states revealed that the process of implementation of the standards began with the development of resources aligned with the curriculum to enhance instruction followed by training for teachers and administrators. Plans to implement the curriculum before the aligned assessments were administered in the 2014-15 school year are in place for all six states. The states revealed using varied formats to train teachers to use the CCSS in the classroom, and plan to align the state assessment program to the CCSS for continuity (Anderson, Harrison & Lewis, 2012).

The Partnership for Assessment of Readiness for College and Careers (PARCC) is a collaboration of 21 states developing an aligned assessment for CCSS in ELAR and math. The consortium elicited the assistance of almost 1,000 educators and parents to provide feedback on the content areas of CCSS for PARCC. In addition, PARCC recruited 24 member educator cadres to become experts on CCSS and PARCC to lead states in the implementation process. These cadres across the country allow educators an opportunity to experience an intensive orientation to the CCSS and PARCC so they may go back to their states and be a catalyst for change in thinking about CCSS as a means to improve student achievement rather than a confusing mandate (Slover, 2012).

PARCC assessments have been designed to measure what a student knows while preventing barriers to student performance. Developers of the PARCC assessments designed them to be aligned with the CCSS to help educators determine whether students are “on track” for college and career preparedness. These summative tests will measure students’ ability to read analytically, compare and synthesize ideas from complex texts, produce analytical writings,

present knowledge gained through research, and synthesize ideas. Districts will also have the opportunity to use diagnostic and midyear tests to inform instruction. These assessments are optional, but they will provide valuable information on student progress and special needs. Students whose diagnostic tests reveal weaknesses in decoding can receive specialized instruction and accommodations. Accommodations come into play as part of the PARCC commitment to ensure fairness for all students taking the assessment, including students with disabilities. Accommodations prevent barriers to student demonstration of learning (Slover, 2012).

It is essential that students competing in the global stage are able to be innovators and adaptive thinkers. The Common Core State Standards that have been adopted by a majority of the states designate the rigorous standards that students must master to prepare them for these future careers. Although, the CCSS provide the expected curriculum, the process allows schools to make the decisions about how the curriculum should be delivered (Richland & Burchinal, 2013).

Heibert and Mesmer (2013) sought to address issues that may arise with the adoption of the CCSS. They suggested that current complexity levels of reading materials are inadequate to prepare students for the rigor of college and careers. It seems that many students who graduate from high school have not been prepared for college because the reading complexity levels of the materials they are required to read do not rise to the level of those they are expected to comprehend in college. The CCSS were designed with a complexity staircase that addresses this issue built into it.

Heibert and Mesmer (2013) cautioned that increasing text complexity, as CCSS requires could present some problems. One problem is financial; the cost of purchasing texts with the increased complexity could strain school budgets. Another problem the authors propose was the

unlikelihood that students who are failing to meet reading proficiency standards with material at the current complexity levels would be successful with texts of increased complexity. They point out that one-third of all third graders cannot read on grade level, and these same students are four times more likely to fail to graduate from high school. Further, two-thirds of fourth graders are reading proficiently on grade level texts.

Also, caution must be taken because motivation suffers when the task becomes too demanding. According to Heibert and Mesmer (2013), this is problematic because American students' motivation is currently at a low level. Several states have grade level gates that serve to retain students if grade level reading proficiency is not achieved. The authors question whether these gates coupled with increased text complexity will result in more students failing (Heibert & Mesmer, 2013). Increased text complexity places a high demand on executive functions, thus increasing the risk of failure for students with executive dysfunction.

Students with Disabilities

This increased risk of failure is concerning all students, but particularly students with disabilities. Individuals with disabilities have proven to be successful in a variety of careers. They are successful not only because they are able to learn the skills and knowledge essential to their careers, but also they have been able to circumnavigate the inevitable barriers their unique disabilities present. These individuals have become successful despite gaps in foundational knowledge.

One challenge that educators face is trying to align the CCSS with programs already in place for students with disabilities. Of particular concern is how CCSS will impact these students' access to the general curriculum, as mandated by NCLB. It is very important that teachers and administrators make themselves aware of inherent executive function deficits that students with disabilities and others could have. Many students struggle with inhibitory control,

cognitive flexibility, and working memory. These struggles translate into failures in beginning and completing assignments, persevering through a task, and organizing their environment, all components of executive function (Constable, 2013).

Difficulties with executive function can cause students to have trouble attending to the lesson. They may be unable to differentiate between relevant or irrelevant details. They may be unable to make connections between new learning and previously learned material. In the written expression piece of CCSS the expectation of the depth of knowledge becomes increasingly difficult with each grade. Students are asked to hold ideas in their mind (working memory) while using the information in another way. They must monitor their writing so that it is logical and sequential even when adding details. Educators must recognize that these executive function deficits can be serious and put students at risk of not accessing the curriculum. They must work to ensure that supports are put into place to counteract these risks (Constable, 2013).

Norton and Boyce (2013) explored the cognitive challenges for two students using the CCSS. The two sixth grade students from a rural school in the Southeastern United States were chosen by their teacher because of reported struggles in math. The students were seen by the researcher for about 30 minutes one or two times per week for a total of seven sessions. These sessions revealed a need for a more comprehensive learning progressions such as operational connections or prerequisites. Norton and Boyce caution that in the coming years CCSS will provide students and teachers with new challenges that could lead to decreased performance on assessments.

Developmental Issues

Goal setting, an executive function skill, requires abstract thought; a stage of development Piaget suggests begins in upper elementary at ages 11-15 during the formal operational stage. Prior to this stage, a child can be said to be in the concrete operational stage, a

stage in which a child experiences his or her environment through physical means, and is just beginning to think abstractly. During the formal operational stage children do not require concrete objects to understand the environment. At this stage of development, a child's thought ability approaches that of an adult. Piaget's theory states that all learners regardless of their stage of development view their world through their own set of experiences. Sometimes a student will encounter something in their environment that is familiar and continues in a state of equilibrium; if the experience is unfamiliar, the student loses equilibrium and in turn builds new structures to accommodate this new experience (Piaget, 2003). This stage of development coincides with the continued maturation or myelination of the brain. This development facilitates the fluid stream of "neural impulses throughout the brain," which makes possible for data to be incorporated among the various portions of the brain (Paus, Worsley, Collins, Blumenthal & Giedd, 2000). This myelination serves as a conductor of sorts to speed up information transfer. In the adolescent, myelination of the prefrontal cortex, the area of the brain that researchers agree houses executive function, begins in the prefrontal cortex. This enables a child to reason, self-regulate, and organize his thoughts and emotions. Also, children of this age are becoming more able to use other parts of the brain in conjunction with the prefrontal cortex to process information from others that allows them to read others' facial or body language to interpret a person's opinions or thoughts (Steinberg, 2011).

Fourth grade students are expected to comprehend and use executive function skills to think abstractly across complex texts while constructing arguments that effectively impart their understanding and ideas. They are asked to consider the views and build on and articulate new ideas with little prompting. These students must be self-regulated so they can make inquiries and use resources to facilitate long term learning (Common Core State Standards, n.d.).

Prevalence of Learning Disabilities

Marilyn Friend shared the federal definition of learning disabilities:

> "Specific learning disability means a disorder in one or more psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in imperfect ability to listen, think speak, read, write, spell, or do mathematical calculation, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia" (Friend, 2011, p.127).

Many typically developing students, as well as those identified as having a learning disability, struggle with some learning deficit, and are known to have incomplete foundations of academic learning. A comparison with cheese illustrates this notion - a child with learning difficulties could be compared to a piece of Swiss cheese. The holes in the cheese represent the gaps in learning experienced by these students. Some holes are larger than others and are seen throughout the cheese much like a student with learning difficulties. Uneven patterns of learning occur in one or more areas. Many of these gaps can, like holes in cheese in the example, be difficult to perceive, thus resulting in unexpected underachievement (Friend, 2011).

Students diagnosed with the learning disabilities are identified by a discrepancy between achievement and ability or what their IQ tells us they should be able to do compared with what they are actually doing academically. Students can also be identified as having a learning disability through the use of Response to Intervention (RTI). The US Department of Education states that nearly 4.8% of all students in the US have been identified as having a learning disability (LD). The characteristics of students with learning disabilities are diverse and often lead to underachievement in the academic setting (Friend, 2011).

Some 80% of students with LD struggle with learning to read. These struggles permeate to all content areas that involve reading. As students move through the grades in school, the complexity of the content steadily increases, and when skill acquisition does not mirror the pace, achievement suffers. With one third of these students failing content area classes, failure on high stakes tests are sure to follow. Math difficulties are also problematic for this population of students. Mathematic problems are divided into two categories: math calculation or math problem solving. The number of students with LD in the area of math increases with each grade level in school, because when faced with failure in one subject a student is less confident in his abilities in other subjects, resulting in failure. Another academic area associated with learning disabilities is written expression. This difficulty manifests as grammatical errors and organization problems. These problems also increase as students move through school (Friend, 2011).

Cognitive characteristics of students with learning difficulties are commonly problems with memory, problems with attention, and problems with metacognition. Working memory deficits are also a common characteristic of students with learning difficulties. Problems with working memory can be manifested by ineffective strategies to learn vocabulary or facts. This working memory deficit affects a student's ability to hold information in his/her mind and use it to solve a problem (Friend, 2011).

Other factors may impact a student's possibility of having a learning disability:

Boys are identified as having a learning disability much more frequently than girls, but girls with learning disabilities often have more severe deficits in academic skills. For many cases, the causes of learning disability are not identified. For the cases that are identified, the causes are generally defined as either psychological or environmental. Psychological causes can include factors of heredity, factors of brain injury, or factors of chemical imbalance.

> Prenatal or prior to birth causes of brain injury can be linked to drug or alcohol abuse, smoking or contracting a disease by the mother. Perinatal or at the time of birth, causes are usually from a lack of oxygen to the brain. Later fever, illnesses, accidents, or head injuries can cause brain injury.
>
> Hereditary factors can also be the cause of learning disabilities. When both parents have a learning disability the chances of their child having a learning disability are as much as 30 to 50 percent. But this could be influenced by other environmental factors. Biochemical factors or chemical imbalance in the brain can also cause learning disabilities. Many of these cases result in inhibitory control deficits in particular.
>
> The environmental factors that can cause learning disability can include: environmental toxins, (e.g. lead poisoning), unhealthy emotional climate, or insufficient cognitive stimulation. Unfortunately, poor instruction at school can also cause learning disabilities. (Friend, 2011)

In addition, attention deficit hyperactivity disorder (ADHD) also impedes learning. The American Psychiatric Association defines ADHD as: "A persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequently displayed and more severe than is typically observed in individuals at a comparable level of development"(p.65). For a student to be diagnosed with ADHD, they must meet the following criteria: exhibit six of nine identifiers in the Diagnostic and Statistical Manual of Mental Disorders, exhibit these behaviors frequently (more than would be seen in typically developing learners), exhibit the behaviors in two or more settings, exhibit the behavior before age seven. Students with ADHD can have one of these three types: ADHD with a predominance in inattention (ADHD-PI), ADHD with a predominance in

hyperactive impulsive type (ADHD-PHI), and ADHD combined for student who display both inattentive and hyperactive symptoms (ADHD-C) (Friend, 2011).

ADHD is the most common behavioral disorder in school age children. Three to seven percent of all students have been identified with ADHD, with boys far more frequently than girls. Teachers often describe students with ADHD with terms: inattentive, forgetful, easily distracted, and careless. A characteristic of ADHD is hyperactivity. This is a significantly higher level of activity than that of their typically developing peers. Some students with ADHD are impulsive. This inhibitory control deficit is characterized by difficulties in waiting for their turn, talking before thinking, and intruding on others (McLeskey, Rosenberg & Westling, 2013).

Problems with attention or inhibitory control in the form of ADHD plague 25% of all students diagnosed with a learning disability. Lack of inhibitory control results in students being easily distracted and acting without thinking. Students with learning disabilities often have metacognitive deficits. This means they have difficulty regulating their thinking. This deficit hinders a student's ability to attend to information for a sufficient period of time or assimilate it with previous learning to comprehend material. It also impedes the thinking processes required to use multiple steps to solve a problem. Using advance organizers is a method of organizing information prior to its presentation to aid in planning and organizing content, which supports executive function, McLeskey, Rosenberg & Westling, 2013).

Executive function difficulties plague many students with ADHD. Working memory, inhibitory control, and cognitive flexibility are all areas of executive function that, when lacking, can adversely affect a students' performance in school (McLeskey, Rosenberg & Westling, 2013). The rigor and increased content complexity of the CCSS and PARCC assessments require the proficient use of strong executive function skills for success. Instructional interventions and

accommodations are sometimes necessary tools teachers can use to support students whose executive function skills are deficient.

Executive Function

Researchers agree that executive functioning is a complex set of mental actions that encompass such high-level processes as goal setting, shifting a mental set when needed, planning, working memory, self-regulation, practicing restraint, organizing, and taking the initiative to begin an activity (Salimpoor & Descrocher, 2006; Newhall, n.d.; Hughes & Ensor, 2009; Singer & Bashir, 1999; Mahone & Hoffman, 2007). Decision-making involves many complex mental skills such as planning, shifting set, and anticipation. It is, therefore, critical that educators should cultivate these executive function skills within their students to ensure their success, particularly in students with learning disabilities (Mahone & Silverman, 2008). CCSS requires the effective use of executive functions because of the increased rigor, complexity, and depth of instruction required to meet the standards.

Inhibitory Control

Self-control or self-regulation is a critical executive function required of students with the CCSS. Sometimes referred to as inhibition, self-control is, in essence, resisting those things that tempt a person to do what they should not do. Also, it involves resisting distractions and staying on task. Students who have inhibition/impulsivity deficits often make errors because they cannot wait. Rushing to give answers many times leads to incorrect answers. If students are taught to wait or work more slowly their performance usually improves (Diamond, 2013).

Inhibitory control is the ability to be in command over the way we choose to attend, behave, or emote, even when encountering enticing distractions. Inhibition is doing those things one should or needs to do instead of what one wants to do. This executive function gives one the benefit of making thoughtful choices instead of simply reacting to stimuli and behaving

impulsively. This skill is helpful when, in a loud, crowded room, one needs to listen to one person (Diamond, 2013). It would be an overwhelming life if you could not filter out non-essential incoming stimuli. It would be nearly impossible to accomplish even the simplest of tasks if you attended to every single sound, texture, smell, or sight in the environment. Inhibition helps us to attend only to those things we deem important enough. These stimuli that 'make the cut' are sent to the area of working memory while all others simply fade away (Kaufman, 2010).

An important component of inhibitory control is general self-control. This control helps one manage feelings in ways that allow for achievement of goals, completion of undertakings, and directing of behavior. For educators, this means students have the ability to remain on task or finish a task even with mounting distractions. Further, self-control is helpful in suppressing the urge to blurt out answers in class or speaking without thinking (Diamond, 2013; Dawson & Guare, 2010).

In the Study of Early Child Care and Youth Development, a sample of 1,364 children from diverse income and racial backgrounds were assessed on executive function and reasoning skills. The results of statistical analysis showed that composite executive function skills and inhibitory skills played an important role in a child's analytical reasoning. Researchers suggest that educators should provide early support to student inhibitory control to ensure maximum success in later academic and life situations (Richland & Burchinal, 2013).

In a recent study, the Social Cognitive Theory Zimmerman three-phase model was examined to determine the different types of self-regulation. The different classes of self-regulation were compared to grade point average (GPA). After taking a self-regulation survey online, based on their answers university students were placed into one of five classes. The classes were described as 1. Non-self-regulating (22%), 2. Forethought-endorsing self-regulating (16%), 3. Performance/reflection self-regulating (12%), 4. Moderately/highly self-regulating

(9%), and 5. Super self-regulating (41%). The students who fell into the 4th and 5th class were all considered competent self-regulators and their GPAs were statistically significantly higher than those in the first three classes (Barnard-Brak, Lan & Paton, 2010).

Researchers conducting a longitudinal study in London with 1,000 participants found that children who were identified as having lower levels of self-control grew into adults that exhibited failing health, higher incidences of drug abuse, financial problems, higher incarceration rates and diminished parenting skills. This was found to be the case even though variables such as intelligence level, gender, and socio-economic level were factored out, signifying the critical importance of self-regulation to not only individuals but to society in general (Moffitt, Poulton & Caspi, 2013).

Working Memory

Working memory is the capacity to maintain bits of data in mind to accomplish a task and the capability to apply such data to solve a problem. The use of working memory is essential for a person to be able to perform a multi-step task, to keep track of prior responses on a multiple answer task, to recall the rules of an activity, or to manipulate data (Salimpoor & Descrocher, 2006). This "mental workspace" is fundamental to many everyday activities (Alloway, 2009). Working memory itself can be divided into four parts: central executive processing, visuo-spatial, phonological loop, and episodic buffer, which are all parts of the central processing portion of executive function (Baddeley, 1996).

Central executive processing

The first part of working memory is generally referred to as central executive processing, and it has been shown to be the portion of the brain that controls attention. It is also responsible for the

processing and regulation of information including accessing information from memory (Alloway, 2009).

Visual and auditory stimuli

The next two parts of working memory deal with the specialized processing of visual and auditory stimuli. The temporary storage of verbal information is handled by the phonological loop component of working memory. This is the little voice that you can hear in your head. In contrast, Baddeley (1996) notes that the visuo-spatial sketchpad, which helps make spatial and visual information organized, processes visual information.

Episodic buffer

The final component of working memory can be described as the episodic buffer. This vital part of the memory helps to cross memories and domains and connect prior knowledge to new information in order to add meaning, and organize these batches of memory to be accessed at a later time (Baddeley, 1996).

Working memory has been shown in studies to be a purer measure of intelligence, because working memory measures capacity for learning. Other measures of intelligence depend on factors of socioeconomic status and prior knowledge (Alloway, 2009). A possible explanation for the poor academic performance of students with working memory deficiency could be the extensive amount of classroom assignments that rely heavily on working memory skills such as composing a narrative; while keeping in mind the details of each character or calculating a math problem while remembering the order of operations. Struggling with these types of activities could place a student at risk for failure later on when the application of such skills is necessary in classes like language arts and math (Gathercole & Alloway, 2006).

Cognitive flexibility

Cognitive flexibility is the ability to 'shift gears' or move from one activity to another. This skill allows a person to think in different ways as needed for a dynamic situation. Without this ability people tend to get "stuck" in one behavior or way of thinking and are disturbed by rapid changes (Kahn & Foster, 2013). This executive skill is about being flexible enough to adjust to changes in situations or take advantage of unforeseen possibilities. This is a “go with the flow” skill that enables students to be creative and open to rich opportunities in the classroom and in life.

Most students are unable to competently switch tasks as an executive skill until the age of seven to nine (Diamond, 2013). This ability to react appropriately to new types of situations is crucial to many problems people encounter daily. In essence, cognitive flexibility is the capability to successfully retrieve and apply previous knowledge to novel situations using an ever changing method of thinking, in terms of varied and numerous ideas (Matthew & Stemler, 2013).

Research on Executive Function

In their 2006 study of students aged 11-12 years, St. Clair-Thompson and Gathercole investigated to find which components of executive function are related to each other and to academic subject success. Fifty-one students from England were participants in the study. The researchers used national curriculum tests the students had taken at the end of primary school and during the first year of secondary school (equivalent to middle school) as tests of achievement. The students were also tested on executive functioning and working memory tasks. The tests consisted of inhibition, shifting, and updating (which are environmental perception skills). The working memory test consisted of visuo-spatial and auditory processing. The scores from these tested components were compared to each other and to the curriculum test from the previous year.

St Clair-Thompson and Gathercole (2006) found several executive functioning skills to be correlated and both working memory tests were correlated. The researchers found significant correlations between English scores on the national curriculum test and working memory. Visuo-spatial scores were correlated with English, science, and mathematics scores. Task shifting was not shown to be significantly correlated with these subjects. Though shifting was not found to be correlated, this skill's importance should not be underestimated, because as much as the ability to maintain focus on a task is crucial, shifting allows one to be flexible in a dynamic environment. It helps in monitoring the environment, using feedback received from the environment, and changing behavior appropriately.

Sometimes the environment can have an impact on executive function. For example in 2007, Garcia-Vaillamisar and Hughes conducted a controlled trial in which adults with autism were shown improvements of executive functioning after two years of supervised employment. Further, improvements in executive function were seen in people with schizophrenia after "cognitive remediation." Finally, a similar result was seen with normally developed preschoolers (Hughes & Ensor, 2009).

Students with low socioeconomic status usually function worse academically than students from higher socioeconomic backgrounds. One reason for this is that they may show "cognitive dysregulation" which could lead to failure even when students are motivated to achieve (Waber, Gerber, Wagner, Forbes & Turcios, 2006). Baddeley (1987) concluded that disparages in socioeconomic status can vary students' academic progress in many ways, including the interactions of parents with the children, the level of family disorder, and the chances for learning through observation. The most important familial factor found, however, was scaffolding by parents. This involves a parent helping a child reach higher levels of learning

before the child can do so independently, hence, the dominance of Vygotskian theories present in the research of executive function (Hughes & Ensor, 2009).

One recent study showed that socioeconomic status (SES) also affected students' extra curricular activities. Students from higher socioeconomic backgrounds spent fewer hours working at after school jobs, less time playing video games and watching television, and more time in school sponsored sports or cultural activities than their lower SES counterparts. These activities have been shown to have an effect on a student's grade point average, putting students with low SES at an even bigger disadvantage (Dumais, 2008).

Many studies show us that executive functions are not static and can be improved and studying these conditions can help researchers to discover more about what causes executive "dysfunction." The bottom line is that this gap in achievement, associated with low SES, puts many of our students at a greater risk of failure in school and then later in their endeavors in life (Waber, Gerber, Wagner, Forbes & Turcious, 2006).

Executive function is a key process of "cognitive, linguistic, behavioral and affective control," which are all important skills closely associated with successful students (Singer, Bashir, 1999). These executive functions are part of a process in which problems are defined and analyzed, and a solution planned before acting on it. Executive functions are also used to set goals that correspond to desires (Singer & Bashire, 1999). Planning for these goals, determining the correct steps to attain them, using imagination necessary to envision the result of the goal, anticipating possible problems, and turning to alternative means to achieve goals are skills associated with intelligence and success in school (Salimpoor & Descrocher, 2006). These skills are also associated with attainment of the Common Core State Standards adopted by the many states in 2010. Among these standards are: making inferences, analyzing texts, interpreting

words to determine meaning, assessing purposes of text, integrating, and evaluating arguments (English, n.d.).

Executive Dysfunction

Students with executive dysfunction may have a hard time organizing or planning, which could be very problematic particularly for fourth grade students, in Piaget's formal operational stage, and even more so for those with learning disabilities. Sometimes they cannot visualize solutions to problems or use strategies to solve them. Goals often have many steps, and failure to plan or anticipate problems could lead to failure. Executive dysfunction symptoms are found in many genetic and other disorders of students and could affect performance on IQ tests and other tasks that require executive functioning. Some of the disorders that have been found to be associated with executive dysfunction are: "attention deficit hyperactivity disorder, autism, obsessive-compulsive disorder, and medical conditions such as insulin dependent diabetes mellitus" (Salimpoor & Descrocher, 2006, p. 17). Additional symptoms of executive dysfunction are inhibition problems, trouble with monitoring behaviors, inability to imagine solutions, inability to organize, and memory problems. Children with developmental disorders are also seen to be at an increased risk of executive dysfunction problems.

Inhibition problems can be manifested as a student becoming easily distracted, or the inability to ignore distractions and control impulses. Sometimes when students become stuck on one solution they cannot use creative thinking to envision alternate solutions, which suggests an inability to shift from one task to another. Being unable to monitor their performance by using feedback is often seen in students with executive dysfunction (Salimpoor & Descrocher, 2006). Further, a student may show signs of executive dysfunction if they have comprehension deficiencies or struggle to tell a story. Being unable to relay details in order, memorize material

and hold it in mind while working are also signs of executive dysfunction (Newhall, n.d.). Even though a student may know math facts or understand procedure, his or her executive dysfunction can cause failure because of attention problems, information-processing problems, organizing problems, integrating or manipulating data to uncover correct answers (Salimpoor & Descrocher, 2006).

Awareness of the potential pitfalls of students with executive function problems or executive dysfunction, and possible remedies is key to ensuring student success at school, and in everyday life situations (Serino, et.al, 2007). For example, students with executive dysfunction often experience difficulty in the classroom because of their inability to keep in mind all the parts of an assignment for long enough to complete it, particularly when the assignment is complex. This complexity might cause a student to forget the verbal directions, specific instructions given by the teacher, or the direction they are going for an assignment. Forgetting like this, if it happens frequently enough, can lead to failure at school (Alloway, 2009). Repeated failure can lead to low self-esteem and other social problems (Serino, Ciaramelli, Santantonio, Malagu, Servadei,& Ladavas, 2007).

A study conducted by Sarver, Rapport, Kofler, Scanlan, Raiker, Altro, & Bolden (2012) looked at differences in portions of students' executive function to see if there was a relationship among attention deficits and "near- and long-term" academic achievement. They noted that attentional deficits had a negative association to general academic achievement. The researchers also concluded that children with attention problems suffer academically across their educational careers.

In a recent study published in *Brain: a Journal of Neurology*, researchers enlisted 36 patients from Cambridge, UK and Buenos Aires, Argentina with lesions in the pre-frontal cortex, the part of the brain that houses the executive functions. The average IQ of the group was 110.3.

The researchers also had a control group of healthy subjects. MRI scans were used to pinpoint the areas of lesions and group them according to the severity of the damage. The subjects were then given fluid intelligence tests, the Culture Fair test, which is an intelligence test that is designed to be free of any cultural bias, followed by the Wisconsin Card Sorting Test and a test of verbal fluency. The results indicated that the experimental group was found to be "significantly impaired." The researchers found that the Verbal Fluency test and the Wisconsin Card Sorting tests correlated with the Culture Fair test. They also found that the location of the frontal lobe lesion did not matter with the results (Roca, Parr, Thompson, Woolgar, Torralva, Antoun, Manes, & Duncan, 2010).

In a second experiment, these researchers enlisted 21 subjects with frontal lobe lesions, some of which were included in the earlier experiment, and they included another group of healthy subjects as a control group. The average IQ of the test group was 111.8 and the healthy group was 114. The Culture Fair test was given to both the experimental and the control group. A total of twelve executive function tests were administered eight of which were subparts of the Ineco Frontal Screening test. The results of experiment two also showed that all tests were correlated positively with the Culture Fair test. This experiment, unlike the first experiment showed differences among subjects with different areas of frontal lobe lesions. There were no significant differences found in the subjects' 12 executive function tests (Roca, Parr, Thompson, Woolgar, Torralva, Antoun, Manes, & Duncan, 2010).

In 2006, Salimpoor and Desrocher found that in school, students with executive dysfunction suffer poor academic performance. This is fundamental for educators to understand because teachers require students to use executive functioning skills frequently, particularly in tasks that embed the Common Core State Standards (English, n.d.).

Interventions

Clearly, all students need to be challenged by a rigorous curriculum like the CCSS. The increased demand for college and career ready students extends to those with disabilities, as well as their general education peers. Saunders, Bethune, Spooner, & Browder, (2013) suggested that Common Core standards are best delivered in "real world" examples. The problem encountered when teaching CCSS to students with learning disabilities or executive dysfunctions were apparent through the gaps or holes in students' foundational knowledge. The researchers suggested that instead of concentrating only on those gaps in foundation, a teacher of CCSS should challenge these students beyond foundational skills by providing scaffolding to support learning the grade level skills, while continuing to work on those foundational need areas.

With the majority of states adopting the CCSS, many are also employing Universal Design for Learning (UDL) to remove barriers for students with learning difficulties. Universal Design for Learning is an approach to teaching in which the teacher crafts instruction with the special needs of all learners considered. Universal Design for Learning fits well with CCSS because it emphasizes teachers' flexibility to allow for students to use multiple methods to demonstrate knowledge. With UDL, teachers anticipate the needs of students and collaborate to plan instructional supports for all (Kurth, 2013).

These instructional supports come in the form of adaptations. Adaptations can come in three different forms according to Kurth (2013). Access adaptations or accommodations support a student's access to the curriculum without changing expectations for achievement. Low-impact adaptations or accommodations are said to alter how the content is taught, but does not change the curriculum content. Finally, high-impact adaptations or modifications support students by changing both the content and delivery of instruction and thus modifying mastery expectations for students. Some general adaptations available to all students include: enlarged text, peer

tutoring, graphic organizers, and calculators. Specific adaptations are unique to a student's specific educational needs. These adaptations can help raise student engagement, lower student competitive behaviors, increase class participation and on-task behaviors, and most importantly support student access to the general curriculum (Kurth, 2013).

Case studies informed researchers of some of the unique challenges that special educators face when implementing the CCSS. Like general education teachers, special educators must study the standards for understanding, but they also have the added task of readjusting instruction to meet the needs of special education students with executive function deficits to safeguard student access to the curriculum (Sauders, Bethune, Spooner, & Browder, 2013).

Sauders et al. suggested a six-part plan to help meet these needs. After the teacher gains an understanding of the CCSS, grade level standards from all domains should be chosen to address using intensive instruction with accommodations. This careful consideration of the CCSS should be a collaborative process between the general and special educator. After choosing the content skill to address, the teacher should search for real world examples to use in instruction such as Internet website or experiential learning. The use of manipulatives was also encouraged for concrete delivery of abstract concepts.

Providing manipulatives and engaging students in experiential learning are examples of evidence-based techniques the researchers encourage teachers to use (SAUDERS, et al). Task analysis of the basic steps or procedures for each skill can also enable a teacher to discover any misconceptions in a procedure. Teachers should also provide students with instructional supports. Graphic organizers can help ease working memory load and assist with problem solving. Using available technology such as calculators and communication devices can promote student understanding and engagement.

Progress monitoring can be an invaluable aid to inform teachers of student learning. It is important to note that like general education students, special education students will move through the curriculum at varying paces. The teacher must make decisions based on the class as a whole about when to move on to new skills, while providing intensive specialized instruction to those students not progressing. Generalization of a skill is a necessary step for teachers of students with disabilities or executive dysfunction. These students need to be allowed to practice a skill in varying contexts for transfer. They should practice story problems with different numbers and scenarios to ensure students have not simply memorized the problem instead of learning the strategy to solve it. Using these techniques will help students with learning difficulties successfully maneuvering the CCSS (Sauders, Bethune, Spooner, & Browder, 2013).

Haager and Vaughn (2013) note the CCSS requires students to be able to read a variety of increasingly complex texts throughout their school years. They should use listening, writing and speaking skills to learn from various texts. Reading and writing are common areas of great need for a majority of students with learning disabilities. So it stands to reason that increasing the rigor and executive function load (requiring students to use several executive functions at once) will increase difficulties for these students and their teachers.

With this in mind, the question becomes: How can teachers get students with executive function deficits where they need to be for success? Intensive explicit instruction on foundational skills can be a start, but the first step again is for the educator to become familiar with the CCSS at all levels. The educator should collaborate with other general education teachers to provide programming for all students. Haager and Vaughn (2013) suggest that the teacher use small group instruction as a way to teach students foundational skills while giving students integrated lessons with guided practice. The educator should provide differentiated instruction and special

support structures for struggling students through flexible activities and using multi-modal opportunities for learning (Haager & Vaughn, 2013).

In the area of History and Social Studies, Bulgren, Graner, and Deshler (2013) recommend using De la Paz's historical reasoning strategies and self-regulation strategies development to address deficits in History and Social Studies. In this method, students were taught how to take notes from texts they had read. They were then instructed on how to use those notes to write an opinion essay.

Further, Bulgren et al. recommended using graphic and enhanced organizers, interactive learning strategies, and post organizers. These high leverage learning strategies help students to develop a plan, execute it and finally use self-regulation to reflect on it, all executive function skills, with support and reinforcement from teachers (Bulgren, Graner & Deshler, 2013).

In grades K-5, CCSS address the fundamentals of math such as counting skills, comparing, addition, subtraction, multiplication, division, place value and fractions. Grades 6 - 8 continue with these foundational skills but delve deeply into geometry. Pre-algebra begins in sixth grade. The complexity increases throughout high school as algebra, statistics, and probability are added. Three to six percent of all students are diagnosed with a learning disability in math. Ninety-five percent of those students struggle with math throughout school and into adulthood. It is estimated that many more students struggle without a proper diagnosis (Powell, Fuchs &Fuchs, 2013).

Students with a difficulty in mathematics (MD) often struggle with counting sets of numbers and telling time (Powell, Fuchs &Fuchs, 2013). This ineffective use of incremental numbers can be related to working memory deficits (Sarver, Rapport, Kofler, Scanlan, Raiker, Altro, & Bolden, 2012). Problem solving was also an area with which students with MD

struggled. Reading comprehension and decoding deficits account for at least part of the problem in this area.

Powell, Fuchs, and Fuchs' (2013) recommendations include intensive and explicit instruction, which includes teacher-modeling problem solving techniques and providing visual aids to ensure understanding. Small group tutoring that emphasizes number concepts, comparing numbers, and number identification in the lower grades has proven to improve student learning for students with MD. Students with MD will struggle even more with the implementation of the more rigorous CCSS, making these and other interventions critical for student access to the curriculum (Powell, Fuchs & Fuchs, 2013).

Numeracy and literacy assessments have demonstrated correlations with working memory capacity, and academic achievement (Alloway. 2009). The researcher discovered that working memory is a predictor of academic achievement, even more so than IQ. Working memory predicted both math and reading skills achievement. The researcher suggests specific interventions for executive dysfunction that can reduce educational difficulties.

Further, Alloway (2009) suggests that specific interventions that target a child's weak areas and provide support for new skill acquisition are crucial to counteract poor executive function skills on academic performance. Teachers can manage their classrooms in such a way as to minimize the working memory load required to complete tasks, while encouraging and teaching the students strategies to prevent forgetting.

The initial course of action for intervention is to determine if the child has an executive function difficulty. There are many tools to aid in the identification of executive dysfunction; one is "automated working memory assessment" (Alloway, 2009). Other tests that have shown to be effective in evaluating executive dysfunction include the Wisconsin Card Sorting Test (Banich, 2009), the Learning and Study Strategies Inventory or LASSI (Lassi, 2010), the Homework

Management Scale (Xu, 2009), and most recently, the Childhood Executive Function Inventory or CHEXI (Thorell & Nyberg, 2008). One difficulty researchers encounter is the fact that the nature of executive function is so complex to measure because of the unique situations in which executive function is used (Banich, 2009).

The LASSI uses ten different scales to diagnose problems. This test reveals a student's strengths as well as weaknesses. The feedback that it provides is helpful to students in terms of the area they need to improve (LASSI, n.d.). The Homework Management Scale measures more environmental factors that influence executive function, such as a student's arrangement of his or her homework space, the students time management, the student's ability to avoid distractions, the student's ability to maintain interest in the project, and a student's ability to maintain control of emotions (Xu & Wu, 2013). The CHEXI, which is still in the testing phase, has shown promising reliability ratings while revealing executive functions more accurately than has previously been shown (Thorell & Nyberg, 2008).

The Trail-making tests (TMT) are frequently used to test executive function in students by assessing task shifting, goal-directed and divided attention, and visual planning. The TMT has a student draw connecting lines between alternating lettered and numbered dots. Speed and accuracy, while completing this process, are measured by the researcher to make up the executive function score (Kaufman, 2010). TMT also uses the executive function skills of cognitive flexibility (Dawson & Guare, 2004). This test has been in use since 1944, when the U. S. Army began using it to test brain function. This test is usually administered to test executive function in two forms. Form A uses numbers to 25 randomly scattered on a page. The subject of the test draws a line from each in order while being timed. In form B, the test subject draws lines between numbers and letters in order, A-1, B-2, etc. The numbers and letters are also randomly scattered on the page. This test is also observed for accuracy and speed. This is a good measure

of a person's ability to switch back and forth between parts of a task, which is an executive function (Takeda, Notoya, Sunahara & Inoue, 2011).

These tests are designed to target specific executive functions, because executive dysfunction can have distinct affects on several different areas of executive function (Salimpoor & Descrocher, 2006). The use of tests of executive function should be used to determine those students whose dysfunction is severe enough to place them in danger of academic failure, so that they might be given the support they need to improve (Waber, Gerber, Wagner, Forbes, & Turcios, 2006).

Direct instruction on study skills including specific feedback is very useful in helping students develop executive functioning skills particularly as the brain is maturing and developing (Newhall, n.d.). Survey, question, read, recite, and review or SQ3R is a reading strategy that allows the natural questioning of students to help them comprehend a passage. Another strategy helpful to students is the Cornell note taking technique. In this strategy, a student must divide his or her paper into two columns, placing key words and concepts in the smaller left-hand column and recording the corresponding notes in the larger right-hand column. The bottom of the pages is reserved for a short summary. Visual organizers such as outlines are also helpful in teaching organization (Kutscher & Moran, 2009). In 2009, Nordell noted that students who attended a workshop devoted to study skills had higher grades on exams than those students who did not attend it.

A specific intervention that targets working memory is paramount to reduce the unwanted consequences of a student's working memory deficit on his or her academic performance. Teachers must be effective classroom managers to reduce the amount of working memory tasks required of such students. An effective strategy is to simplify assignments and repeat instructions

while helping the student use strategies to keep working memory from becoming overloaded (Gathercole & Alloway, 2006).

Study skills interventions have been shown to have a significant effect on young students' "academic outcomes" (Bail, Zhang & Tachiyama, 2008). Deep learning can be enhanced with the use of organizational techniques. These techniques enable students to "bridge the gap between" those things that students already know and the things they need to know. Study skills are considered by many educators to be key to students' performance in academic situations (Sinkavich, 1994). Researchers concur that the idea of a "study strategy" needs to include a mixture of "behaviors and activities" like being personally motivated, storing mental information, taking notes, scheduling, organizing data, concentrating, and note-taking (Yip, 2007).

In 2007, Yip studied the relationship between academic achievement and learning strategies at Hong Kong University, and found after administering the LASSI, that academic achievement and study strategies are related. He also found that academic success could be determined by study strategies. In 2013, Xu and Wu found that academic achievement was related to all five subscales of homework management. Further, he found that those students who were said to be highly academically successful compared to lower academically achieving students described higher frequency of budgeting time, handling distractions, managing workspace, and controlling emotions while completing homework.

Other strategies teachers can employ to assist students with executive dysfunction include: using visual organizers, using timers, computers with alarms, giving written directions, planning transitions, managing time, creating checklists, creating to-do lists, using calendars to record important information, and encouraging the use of a day planner (Newhall, n.d.).

In 2009, first year business majors at a university were asked to keep time logs for two weeks. The researchers found, from these logs, that the freshmen did not have the skill set for managing time that would enable them to be successful in the business program. After interviewing students they found that the maintenance of the time logs was enlightening to them and helped them to realize that in order to maximize their time use, they needed to know exactly how they spent their time (Fischer & Lehman, 2005).

Supplemental study skills instruction was found to be associated with fewer low grades, and higher graduation rates, in targeted classes (Bail, Zhang, & Tachiyama, 2008). Researchers suggest that educators help students to understand how and when to use specific study strategies, so they can apply them to any area of the curriculum. They recommend students be taught how to recognize the need for the use of executive function and "self-regulating behaviors" so that the students might become risk takers and learn and communicate more effectively, while customizing specific study strategies to accommodate their own needs (Singer & Bashir, 1999).

Self-regulated learning denotes those willful actions on the part of students to learn. These types of behaviors like those of executive function include setting goals, managing time, strategizing tasks, structuring the environment, and seeking help. Self-regulated learning assumes that students can have some control in their own lives. Students' who employ self-regulation in their academic activities seem to achieve better learning outcomes than learners who fail to exhibit self-regulating behaviors. Researchers have found several different levels of self-regulating behaviors in learners, and these differences translate into different levels of academic success (Bernard-Brak, Lan, & Paton, 2010).

There are several non-academic behaviors that can be considered as part of the learning process, self-regulation being one. The quantity and quality of learning are related to the students' ability to self-regulate (McCombs & Whisler, 1989; Sinkavich, 1994). This type of

contemplative assessment together with the use of rubrics, outlines, and other self-assessments encourage students into metacognition, which will increase students' awareness of how they learn while they are developing skills and strategies for learning (Bingham, Holbrook & Meyers, 2010). Studies reveal that students skilled at metacognitive strategies and who possess an "internal locus of control" are able to visualize choices and behaviors more accurately. This could result in better academic progress and a success orientation (Hall, Smith, Chia, & 2008). A student's belief in the value of studying, and his or her decisions about how and when to study, and his or her ability to accurately estimate test readiness can all be considered metacognitive skills (Duell, 1986; Sinkavich, 1994).

Another critical executive function skill is time management. In the 1991 study by Britton and Tessor, data suggested that time management self-reporting was related to achievement in school. The study proposed that self-reporting of time management was even more closely related to achievement than SAT score.

In a 2008 study, 231 students in Canada kept a five-day diary of how they spent their time. They also completed a questionnaire that evaluated the influence of attitude and thinking factors on achievement. The results showed that the most influence on grade point average was time management skills, amount of time a student spent studying, and clearly defined goals (George, Dixon, Stansal, Gelb, & Pheri, 2008). Achievement and learning are future oriented, since many tasks students are asked to complete are not only valuable in the present situation but also in the future. This "future time perspective" highlights the value of future goals to help motivate students to be persistent in their studies. When teachers encourage students to make goals, they become more efficient, interested, and perform better on tasks (Simons, Dequitte, & Lens, 2004).

The Pomodoro Technique by Francesco Cirillo (2006) is a study curriculum designed to support learners with executive function deficits. This curriculum uses a timer to teach the value of being aware of time. An important component of the Pomodoro Technique is teaching organizational and inhibition skills. Learners gather materials make goals, and work in 25 minute "pomodoros" to complete assignments without distractions.

Recording and looking back on how long it takes to accomplish a goal can help with metacognition. Thinking about how one might improve performance, time management, goal setting, and organization are all executive skills that could be improved using the Pomodoro Technique (Cirillo, 2006).

The timer is central to the Pomodoro Technique because time boxing is used to teach time management. A Pomodoro is a unit of time consisting of 25 minutes of work and a five-minute break; using a timer is crucial. This unit of time must be uninterrupted. If while working on a Pomodoro an interruption occurs, the student cannot record the pomodoro as complete (Cirillo, 2006).

Avoiding interruptions (inhibition) is another important piece to this strategy. Before the timer is started, the student must work to ensure that all foreseeable disruptions are eliminated. The student should make sure that basic needs have been met. A note could be placed on the door, and all phones turned off during a Pomodoro. The student should be provided with time to think without intrusions from outside sources (Cirillo, 2006).

Intrusions can come from internal sources also. Preventing these types of delays in working is critical. The student must prepare all materials prior to the beginning of the Pomodoro. Pencils, books, paper, or other necessary items should be at the users fingertips. It is important that the student is free from the distractions that involve assembling materials needed. The student must be free to simply start working as soon as the timer starts (Cirillo, 2006).

The student lists all the different activities that need to be worked on at any given time as they occur on "An Activity Inventory Sheet." The "To Do Today Sheet" is used to list the goals/tasks to accomplish that day. During the Pomodoro, the student works for the entire uninterrupted 25 minutes. When the timer goes off, an X is placed next to the item on the "To Do Today" sheet. Following the Pomodoro the student must take a mandatory five-minute break. After working for four Pomodoros a longer fifteen to thirty minute break should be taken (Cirillo, 2006).

At the end of the day, the Pomodoros should be recorded. It is recommended to record the actual number of Pomodoros it took to finish an activity. This will result in improvement on time estimation skills and time on task. Recording and looking back on how long it takes to accomplish a goal can help with metacognition. Thinking about how one might improve performance, time management, goal setting, and organization are all executive skills that could be improved using the Pomodoro Technique. The Pomodoro should be incorporated in the regular day's activities. Using a Pomodoro will improve executive skills throughout the day across many domains (Cirillo, 2006).

Summary

This comprehensive review of the literature highlighted many themes related to the achievement of students with executive dysfunction. It outlined the state of accountability in the nation, the Common Core State Standards, students with disabilities, executive function/dysfunction, and interventions to support students with executive dysfunction.

The literature review revealed that the state of accountability in the nation is dynamic and schools are working to keep up with the changes for the benefit of students. The current iteration of NCLB and initiatives driven by the Obama administration are all designed to ensure students

get the best education that will prepare them for the competition they will inevitably face in a global marketplace.

The states' answer to the accountability mandate is, for most, Common Core State Standards. These standards were designed to increase rigor and deepen content complexity to prepare students for their future in college and careers. Universal Design for Learning embedded in CCSS served to protect students with disabilities from barriers to their access to the curriculum, and the PARCC assessments ensure that the accountability required by law is met fairly for all students.

The literature review gives insight into what researchers and leading figures in education believe are the characteristics, causes, and prevalence of learning disability and ADHD. A common thread was found; many students with a learning disability and virtually all students with ADHD experience difficulty in academics because of an executive dysfunction. Likewise, students without a specific learning disability can benefit from the strategies to enhance executive function.

Executive function was explored as to its physiology, its function in academics, and its role in general student success. The executive functions of inhibitory control, working memory, and cognitive flexibility were examined as they relate to academic achievement. Executive dysfunction was found to be related to failure in school and later general quality of life. The causes and prevalence among students with disabilities and ADHD were reviewed.

The literature is abundant with examples of instructional interventions for executive dysfunction. Studies from across the world have given insight as to strategies for support for students with executive function deficits. Many students with learning disabilities or ADHD have executive dysfunction, and executive dysfunctions cause academic difficulties. Under achieving students spur lawmakers and educational leaders to call for accountability, and

accountability and incentives like RTT spur states to develop more rigorous and complex standards. Rigorous and complex standards place a heavy burden on executive function of students, leading to potentially more academic difficulties. This cycle can be averted with intensive and explicit academic interventions targeted to each student's individual needs.

The question not answered by the literature remains: How do specific executive function interventions affect middle school students' executive function and academic success in meeting Common Core State Standards?

CHAPTER 3

Methodology

This study focused on the execution of a set of instructional strategies revealed in the literature review to be effective in improving student executive function for the purpose of increasing student achievement in the rigorous and complex CCSS. The study strategies included in the executive function skills instruction or Pomodoro Technique include: using visual organizers (Working Memory), managing time, planning transitions (Cognitive Flexibility), creating and using to-do lists, recording data, self-regulation (Inhibitory Control), self-assessment, metacognition, defining goals, and reducing working memory load.

This study provided information for educators regarding the development and implementation of executive function study strategies. The results of this study provided data that assisted in determining whether a significant difference in the mean executive function and achievement scores of students who received executive function skills instruction and students in the control group who did not receive executive function skills instruction.

The proposed quasi-experimental study sought to determine whether the executive function level of a student has an impact on the students' academic success in meeting increased rigor and high demands of the CCSS. The literature indicated that students with higher executive function skills would experience a higher level of success, so determining whether executive function skills instruction will increase student executive function level and thus impact achievement in meeting the CCSS was the focus of this study.

Research Questions to be addressed:

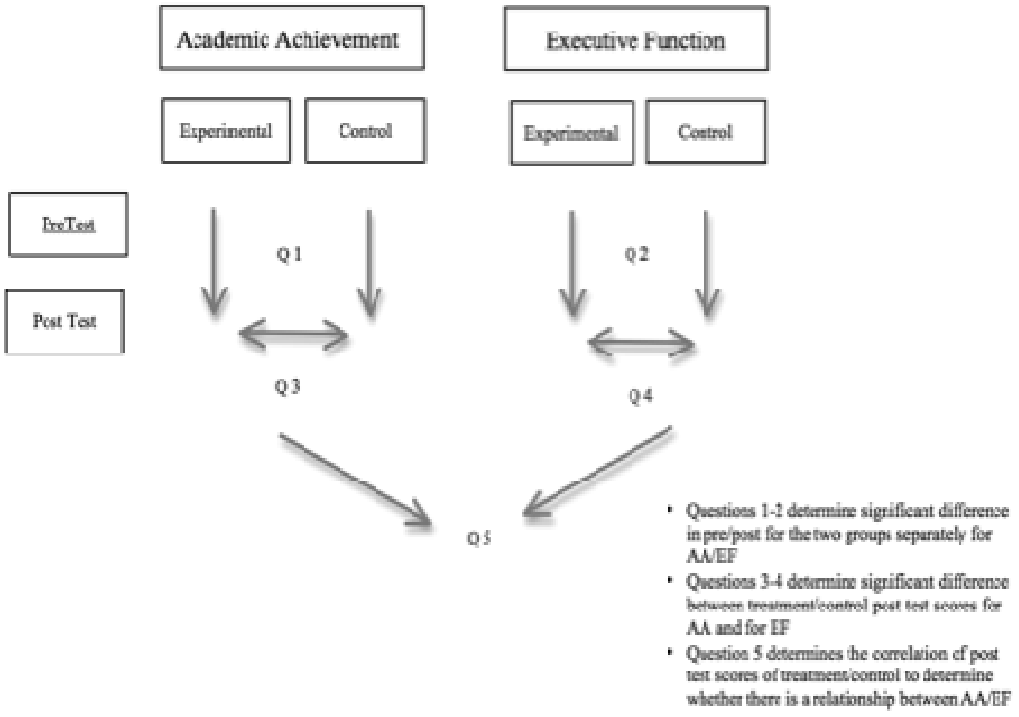
1.Is there a significant difference in the *academic achievement* from the pretest to the posttest of the experimental group and the control group separately?

2.Is there a significant difference in the *executive function levels* from the pretest to the posttest of the experimental group and the control group separately?

3.Is there a significant difference in the *academic achievement* of the pretest and posttest results between the two groups?

4.Is there a significant difference in the *executive function levels* of the pretest and posttest results between the two groups?

5.Is there a correlation between the *academic achievement* and *executive function levels* based on posttests results of the two groups?



Participants

The sample for this study was fourth grade students from a rural public school in North Mississippi. At the beginning of the school year, the participants were randomly assigned to a teacher by a computer software program used by the school to assign all students. The teacher was selected because of her willingness to participate and interest in the subject. The selected teacher was the language arts teacher and she taught two groups of 25 students. These students were representative to the general population of fourth grade students enrolled in rural public schools and engaged with the CCSS. The researcher did not restrict any student from participation. The school district was chosen because it is fully immersed in curriculum preparing students for the CCSS. These fourth graders were taught using this curriculum their entire educational careers. The students were from a relatively high performing school district with highly qualified teachers. The school was situated in a community of approximately 5,800 people. The median income was $37,792 and the average house value was $97,886. The racial breakdown of the community was as follows: White-60.4%, Hispanic-23.6%, Black-14.2%. The unemployment rate was 7.6% (Pontotoc, Mississippi, n.d.).

The morning group was selected as the experimental group because that block of time had an additional eight minutes. The experimental group was given instruction using the Pomodoro Technique and practice using it throughout the day. The students were also encouraged to use the technique at home. The control group continued instruction as usual without instruction on or the use of the Pomodoro Technique.

Design

A quasi-experimental empirical design was chosen for this study in an effort to answer the research questions. The researcher sought to determine the impact of the intervention on the

experimental group. To avoid problems with internal validity, a control group was used. Further, the researcher chose to use one teacher for both groups in an effort to ensure validity by eliminating the possibility that differences in teaching styles of multiple teachers might affect results.

After gaining approval from the Institutional Review Board and prior to the beginning of the treatment period, the researcher administered the Trailmaking test of executive function to each participating student. The researcher tested the students using an Ipad application. A score for executive function was derived from the application. The executive function score was one variable and the students' achievement was the other variable. In addition to the Trailmaking test, the classroom teacher administered the CASE pretest of achievement that assessed common core standards, which was the district adopted common assessment taken three times per year. The researcher trained the classroom teacher on the use of the Pomodoro Technique, and the treatment began after permission letters were returned from all participating students. The teacher implemented the Pomodoro Technique with the experimental group while continuing with the CCSS instruction in both experimental and control groups for a nine-week grading period.

Instruments

Scientists at the Sydney alliance for Healthcare, Research and Training developed the NeuRA trail making test application for the Ipad (Neuroscience, n.d.). This test included a sample trail to familiarize the participant with the mechanics and to help them know what to expect. Following the sample, the test began with a Trail A test.

This Trail A test consisted of 25 circles with numbers inside randomly placed on the screen. The participant touched the screen with a finger and traced between the numbers,

essentially connecting the dots. The application recorded the amount of time it took for this trail to be made.

Immediately after Trail A, a sample for Trail B was administered. In this trail the participant alternated between randomly placed circles containing numbers and letters, for example 1-A-2-B-3-C. This sample was then followed by the Trail B test. The application also recorded the amount of time it took to complete this trail. The entire battery of tests and samples took less than five minutes to complete.

The A and B trail making tests demanded instantaneous identification and sequence of numbers and letters, capacity to continuously visually search the page to determine the next letter or number in the trail, cognitive flexibility to task switch back and forth in the correct sequence and the achievement of the above while experiencing the added pressure of time (Reitan & Wolfson, 1992).

The computer application form of the Trailmaking test (TMT) has been shown to be as reliable as the paper and pencil version. Research has shown that the computer-assisted form of the TMT was valid and reliable for testing the executive functions of: cognitive flexibility, task switching, and visual scanning. The authors point out that because of the inherent nature of the Trail B, it provided a truer measure of executive function than the other parts of the test. This can be explained by considering the process of the trail B. As the tester progressed through the test, the letter/number sequencing determination became more rigorous, so task switching and cognitive flexibility (both executive functions) were used at a higher rate. The computerized TMT was a valid and reliable alternative to the paper and pencil TMT with the added benefit of reducing administrator error. These errors included: computational, time keeping, and scoring (Poreh, Miller, Dines, & Levin, n.d.).

Each trail on the TMT was scored individually based on the seconds it took the subject to complete the task. The executive function score was the trail B minus trail A. The larger the number, the lower the executive function level. The mean score for trail A was 29 seconds, a score > 78 was said to be deficient. The mean score for trail B was 75 seconds, and a score of > 273 seconds was considered deficient. If a student completed trail A in 40 seconds and took 120 seconds to complete trail B the executive function score would be 80. This score could be compared to the norm score of 46. The lack of norms for elementary school students, though problematic would not affect the current study, which focused on the gains not actual scores. The researcher was not making judgments based on the current level of executive function or academic achievement, only gains (Trail Making Test, 2004).

The students also were tested for achievement on CCSS using the CASE assessment for the 4th grade, used by all students. The scores from the language arts reading tests were used for analysis. These tests were used as a pretest and were repeated as a posttest after the nine-week treatment period.

The CASE assessment was developed by the Training and Education in the 21st Century Company. The CASE developers worked closely with each school district to craft an assessment that was useful for educators as a diagnostic tool. This assessment was developed to provide teachers with feedback on student progress and practice for state assessments. The test was closely aligned with the CCSS in language arts and math. The questions were crafted to reflect the format of the CCSS state assessment. The majority of the items are higher depth of knowledge questions (TE21Training, n.d.).

Experienced teachers developed the items for this assessment. The development of each item is analyzed by a group of curriculum specialists for alignment to the CCSS, difficulty, grade

appropriateness, and content specific vocabulary. Each item was further reviewed by senior managers and editors to assess format, grammar, and quality characteristics before being submitted for administration to students (TE21Training,n.d.).

The CASE tests were graded on a 100-point scale for clarity, and a report with scores can be generated after administration. The score reports provided the teacher with specific data on items such as text complexity and depth of knowledge level, however; only the overall score was used for this study. The tests were given three times per year: mid-October, January, and mid-March. The growth from the October through January assessments prior to the treatment provided additional information about the baseline score to bolster any findings of change in the scores of the treatment group on the test administered mid-March (TE21Training,n.d.).

Treatment

The experimental group was instructed for a full nine-week grading period on the following skills based on the Pomodoro Technique:

1. Plan goals/tasks for the day - The students received direct instruction on preparing an activity list of goals/tasks. The instruction consisted of think alouds, demonstration, and modeling, followed by collaborative engagement, and finally independent application.
2. Prioritization of tasks – The students received direct instruction on the prioritization of tasks. The students learned how to consider each item's importance and due date to determine in which order they should be accomplished. The tasks were then written on the To-Do list.
3. Organization of materials – The students received direct instruction on the organization of needed materials for each activity e.g. diagrams, colored pencils, highlighters, or notebook.

4. Time management - The students were instructed to immediately begin working once the timer began, and to be mindful of time as they plan activities to be accomplished.

The teacher encouraged the students to use the technique by providing opportunities throughout the morning block, requiring the students to use the technique at least one time per day. For example, the teacher assigned the students to complete spelling, vocabulary, and social studies reading during a Pomodoro started at the end of the morning block. The students were also encouraged to use Pomodoros at home for completing homework. Activity sheets were available to students to use at school and at home. Each morning, during morning meeting, the teacher gave students the opportunity to share ways in which the Pomodoro was used at home or in math block.

Hypotheses

1. Ho: There is no significant difference in the *academic achievement* from the pretest to the posttest of the experimental group and the control group.
2. Ho: There is no significant difference in the *executive function levels* from the pretest to the posttest of the experimental group and the control group.
3. Ho: There is no significant difference in the *academic achievement* of the pretest and posttest results between the two groups.
4. Ho: There is no significant difference in the *executive function levels* of the pretest and posttest results between the two groups.
5. Ho: There is no correlation between the *academic achievement* and *executive function levels* based on posttests results of the two groups.

Data Analysis

An independent T-test was used to determine whether there was a significant mean difference in the pre- and posttest achievement scores of the treatment group and the control group after the nine-week treatment period of executive function skills instruction. The T-test was also used to determine whether there was a significant mean difference in the pre- and posttest executive function scores of the treatment group and the control group after the treatment period.

A paired or dependent T-test was used to determine whether there was a significant difference in the growth between the pre-and posttests for both the treatment and control groups.

The executive function scores were entered into the Excel program along with the subjects' CASE score. These scores were then transferred to SPSS and a scatter plot was generated with the CASE score being a function of executive function for both sets of data (experimental and control). This showed whether there was a relationship between the variables. A bivariate correlation was then conducted to determine whether a relationship was found. The researcher used SPSS to calculate a Pearson's r one-tailed correlation. After conducting the calculation, the researcher used the results to determine the strength of the relationship, whether the relationship was positive or negative, and whether the correlation was statistically significant.

CHAPTER 4

Results

Introduction

The purpose of this quantitative research study was to consider the effects of executive function skills instruction on student executive function levels and academic achievement on CCSS assessments. This chapter presents the data collected during the study. An independent T-test, a paired T-test, ANCOVA, and a bivariate correlation were used to analyze and organize the resulting data.

The tests that were used to collect the data were the Trailmaking Test and the CASE Achievement Test. Both tests were readily available to the researcher and used familiar formats for the students. The CASE assessment was a publication of TE21, Inc. This benchmark test was developed specifically for the participating school district. The assessment was designed to prepare students for assessment of the CCSS, and it provided useful information to teachers during the school year about student progress with the standards. The students were very familiar with the format of the test.

The format for the Trailmaking Test was also familiar to the students. It was administered via IPad, and it resembled a game. The familiar dot-to-dot pattern was used to determine the student's executive function level. The students followed the instructions of the researcher and were given a score for Trail A and Trail B. Trail A consisted of consecutive numbers only, and the student was timed while completing it. Trail B was more complex and required the student to

shift from numbers to letters in a pattern 1 - A, 2 - B, etc. while also being timed. The researcher recorded the timing data and subtracted the Trail A score from the Trail B score. The resulting number represented the students' executive function score; a lower score indicates a higher level of executive functioning. The students were given this test at the beginning of the experimental period as a pretest after permission from the Institutional Review Board was obtained. The researcher sent home an informative letter to parents advising them of the study and their rights.

The CASE pretest was given to the students in late December just prior to the end of the first semester. The researcher protected the identities of the students by providing them with a number. This number key was kept by the classroom teacher in a locked filing cabinet. The teacher used the code to provide the CASE scores to the researcher and the researcher used the codes to test the students for executive function. For example, the researcher called for student 13 to take the Trailmaking Test. The classroom teacher looked at the code key and sent the appropriate student to the room across the hall to take the test with the researcher. In this way the students' identities were protected. The data was then entered into a spreadsheet to use to transfer to SPSS for statistical analysis.

The data was collected for the experimental and control group on the same days. The CASE assessment was given to each group in class as a whole group during the normal class period. The experimental group took the test in the morning and the control group took the test in the afternoon. This was in accordance to the school protocol. These CASE assessments were normally scheduled tests that the school was administering to all students. Using these tests prevented students from missing instructional time.

Also, in an effort to minimize students missing instructional time, the researcher was careful to schedule a time to administer the Trailmaking test with the classroom teacher. The

researcher reserved a room across the hall to give the executive function pre tests and posttests. The students were called by their assigned number to the testing room to have a brief tutorial with the researcher. The student then proceeded to take the sample Trail A for practice, and then they took the actual Trail A test. This was immediately followed by short instructions on taking the Trail B sample test and finally the Trail B test. The entire time spent out of the classroom was less than five minutes per student.

The students in the experimental group were instructed on and implemented the Pomodoro Technique for a nine-week period. Each day the students were given time for a Pomodoro and the teacher facilitated it. The control group did not learn about or use the Pomodoro Technique, and they continued with class as usual.

The experimental group consisted of twenty students. One student moved into the class after the CASE pretest was given, so she did not have an achievement pretest score. two students were absent when the CASE posttest was given, so they did not have an achievement posttest score. The control group consisted of 19 students. Three students in this class did not take the CASE pretest, so they did not have an achievement pretest score.

Research Questions

Research Question One

The first research question to be addressed was: Is there a significant difference in the academic achievement from the pretest to the posttest of the experimental group and the control group separately? To answer this question, the researcher used a paired samples *t* test. The scores for the CASE pretest and posttest were entered into SPSS and the results are as follows: Experimental group - The mean achievement score decreased from 64.69 (*sd* = 2.84) on the pretest to 47 (*sd* = 4.02) on the posttest. The difference between the two means is significant at

the .05 level (t = 3.33, *df=15).* Control group: The mean achievement score decreased from 75.1 (*sd* =3.08) on the pretest to 59 (*sd* =3.8) on the posttest. The difference between the two means is significant at the .05 level (t =6.24, df = 15).

Research Question Two

The second research question that was addressed was: Is there a significant difference in the executive function levels from the pretest to the posttest of the experimental group and the control group separately? To answer this question the researcher used a paired samples t test. The scores for the Trailmaking pretest and posttest were entered into SPSS and the results were as follows: Experimental group - The mean executive function scores decreased from 70.99 (*sd* =8.97) on the pretest to 52.25 (*sd* =4.7) on the posttest. The difference between the two means was significant at the .05 level (t = 2.56, df =19). Control group - The average executive function score decreased from 69.99 (*sd* =12.37) on the pretest to 48.26 (*sd* =6.29) on the posttest. The difference between the two means was not significant at the .05 level (t = 2.095, df = 18). The mean score for the experimental group decreased 18.74 points, and the mean score for the control group decreased 21.73 points.

Research Question Three

The third research question that was addressed was: Is there a significant difference in the academic achievement of the posttest results between the two groups? To answer this question, the researcher used an independent samples t test. The posttest scores for the CASE assessment were entered into SPSS and the results were as follows: There were 18 students in the experimental group and 19 students in the control group. An independent samples t test was conducted to determine if there were differences in achievement posttest scores between the experimental and control groups. There were no outliers in the data, as assessed by visual

inspection of a boxplot. Achievement score for both groups were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$), and there was homogeneity of variances, as assessed by Levene's test for equality of variances ($p=.515$). The achievement scores were higher for the control group (57.26 + or - 3.39) than the experimental group (45.67 + or - 3.68). This t test revealed that there was a statistically significant difference in the mean achievement scores between the experimental and control groups, $t (35) = -2.32$, $p = 0.515$. However, when an analysis of covariance test was conducted to factor out the pretest variable, the following results were shown: There was a linear relationship between the posttest scores for achievement and executive function, as assessed by visual inspection of a scatterplot. There was homogeneity of regression slopes as the interaction term was not statistically significant, $F(1,30) = 0.538$, $p = 0.018$. The standardized residuals were normally distributed as assessed by Shapiro-Wilk's test ($p > .05$). There was homoscedasticity and homogeneity of variances, as assessed by visual inspection of a scatterplot and Levene's homogeneity of variance ($p = 0.662$). There were no outliers in the data, as assessed by no cases with standardized residuals greater than + or - 3 standard deviations. After adjustment for the pretest of achievement, there was no statistically significant difference in the posttest achievement test scores of the experimental and control groups.

Research Question Four

The fourth research question that was addressed was: Is there a significant difference in the executive function levels of the posttest of the two groups. To answer this question, the researcher used an independent samples *t* test. The posttest scores for the Trailmaking test were entered into SPSS and the results were as follows: There were 20 students in the experimental group and 19 students in the control group. There were no outliers in the data as assessed by the

inspection of a boxplot for the values greater than 1.5 box length from the edge of the box. The experimental group's scores were normally distributed as assessed by the Shapiro-Wilk's test ($p > .05$). The executive function scores for the control group were not normally distributed as assessed by Shapiro-Wilk's test. Because of the problem with normal distribution the data was transformed using SPSS and the experimental group's mean score for executive function was higher ($m = 7.08$, $SD = 0.33$) than the control group's scores ($m = 6.69$, $SD = 0.445$). The Levene's test for equality in variance ($p = 0.478$) revealed that there was homogeneity of variances for the groups. The control group's mean executive function posttest score was .49, 95% CI (-0.72 to 1.51) higher than the experimental group. The independent t test did not detect a statistically significant difference in the executive function posttest scores between the experimental and control groups, $p = 0.478$). In an effort to clarify these results and factor out the covariate, the researcher also ran an Analysis of Covariance test on this data, and after adjustment for the pretest for executive function scores, there was still no statistically significant difference detected in the posttest scores.

Research Question Five

The final research question addressed by this research study was: Is there a correlation between the academic achievement and executive function levels based on the posttest results of the two groups? To answer this question the researcher prepared to conduct a bivariate Pearson's R correlation by generating a scatterplot. The results of the scatterplot revealed there was not a linear relationship, so a Pearson's R correlation was not appropriate to conduct. A Spearman's rank order correlation was run to assess the relationship between academic achievement and executive function posttest scores for the experimental group. There was a weak negative correlation that was found to be not statistically significant, $rs (16) = 0 -0.221$, $p = 0.377$.

Similarly, the scatterplot for the control group did not reveal a linear relationship, so a Spearman's rand order correlation was also run to assess the relationship between academic achievement and executive function posttest scores for the control group. There was a moderate negative correlation that was found to be not statistically significant, rs (17) = -0.497, p = 0 .030.

Conclusion

The results of the data varied. The difference in the executive function levels from pretest to posttest decreased significantly for the experimental group. The difference in academic achievement from the pretest to the post test in both groups decreased significantly. The executive function levels from pretest to posttest also decreased for the control group, but the decrease was not found to be significant. The difference in the mean academic achievement scores for the two groups was significant in that the control group scored higher than the experimental group, however, after conducting an analysis of covariance to factor out the pretest scores the difference was revealed to be not statistically significant. The difference in the mean executive function scores of the two groups was not found to be statistically significant even when the covariate of the pretest scores was factored out. A weak negative correlation was found between executive function and academic achievement of the experimental group, but the finding was not statistically significant. A moderate negative correlation was found between executive function and academic achievement of the control group, but the correlation was not significant.

CHAPTER 5

Summary of the Findings

Introduction

Student success in the CCSS requires extensive executive function skills. With such an emphasis on high stakes assessments, teachers need strategies to help students improve the executive function of students. Improvement in executive function skills could be accomplished with specialized skills instruction using study skills programs like the Pomodoro Technique. This study explored the impact of specific executive function skills instruction on executive function levels and academic achievement on CCSS assessments. This was accomplished by using the Pomodoro Technique for nine weeks with the experimental group while maintaining normal classroom instruction with the control group. The Pomodoro Technique was used to help students improve executive function skills in the areas of managing time, using visual organizers, planning transitions, creating to-do lists, recording and reflecting on data, self-regulation, and reducing working memory load. The classroom teacher facilitated the implementation of the Pomodoro Technique in the experimental group during the study. The students were tested using the CASE assessment for achievement and the Trailmaking test for executive function.

This research study was conducted to explore the Pomodoro Technique as a means for classroom teachers to help students improve executive skills and in turn improve achievement on CCSS assessments which are require heavy use of executive skills.

Results

The first research question asked whether there was a difference in the academic achievement from the pretest to the posttest in the experimental group and the control group. The results of this hypothesis indicate that although a difference was seen, and it was statistically significant, it was not an improvement. The mean achievement scores obtained through the CASE assessment pretest and posttest decreased for both groups. The control groups posttest scores were higher those of the experimental group.

The results of the data analysis for the first research question were troubling. In an effort to understand the reason for the decline in achievement test scores, the researcher investigated the testing conditions. This investigation revealed that the students were tested under somewhat unusual testing conditions. During the testing period of two days, the National Weather Service issued a winter storm warning for the area the school district is located. During testing, the students were distracted by sight of sleet and snow falling, constant interruptions from the office intercom (as parents were picking up students early from school), and the general excitement children have when it snows. These factors could have contributed to the overall decline in test scores.

The second research question asked whether there was a difference in executive function levels from pretest to posttest in each group. For this question, the desired results were a decrease in the score, because the lower the executive function score the higher the executive function level. The results of this hypothesis indicate that the experimental group executive function scores taken from the Trailmaking Test decreased from the pretest to the posttest and the decrease was found to be statistically significant. The control group's scores decreased as well, but the decrease was not found to be statistically significant. This finding suggests executive function skills instruction can have a positive affect on executive function levels.

The third research question asked is there a significant difference in the academic achievement of the posttest results between the two groups. The results of this hypothesis indicate that the academic achievement scores for both groups decreased. When the independent t test was run it was found that the mean control group score was significantly higher than that of the experimental group, however when an analysis of covariance was run to factor out the covariate of the pretest score no statistically significant difference in the means was found. Both the control and the experimental group's score decreased evenly, so we can conclude that the decrease was probably not due to the treatment, but the extenuating circumstances as described in research question one.

The fourth research question asked whether there was a difference in the mean executive function posttest scores of both groups. The results from this hypothesis indicate that both groups' executive function scores improved, and although the experimental scores improved more than the control group, the difference was not seen to be significant with an independent t test. For clarity, an analysis of covariance was run to factor out the covariate pretest scores. This test also failed to detect a significant difference in the mean scores.

The fifth and final question of the study asked whether there was a correlation between mean academic achievement pretest scores and mean executive function posttest scores. The results of this hypothesis indicate a moderate negative correlation was found, however, the correlation was not statistically significant. The negative correlation was expected, because the lower the executive function score the higher the level of executive function. This correlation might be weak because of problems with the sample (Taylor, 1990). The researcher had no control over the groupings of students in the classroom, either experimental or control. The students were placed in each class based on school personnel and student needs, so they were not

necessarily evenly matched. The teacher commented that she had more intellectually gifted students in the control group.

In summary, the CASE test results did not reveal an increase in academic achievement for either group; however this could be due to testing conditions. The results of the Trailmaking Test did show a significant difference in experimental group after use of the Pomodoro technique. There was no significant difference between the groups for academic achievement or executive function, which was surprising. There was a moderate negative correlation between academic achievement and executive function for the control group and a weak negative correlation for the experimental group.

Context of Findings

The finding of a significant increase in executive function levels in the experimental group and not in the control group was encouraging and consistent with studies found in the literature (Hughes & Ensor, 2009). It suggested that the Pomodoro Technique was a viable strategy that teachers can use to help students improve executive function. It also bolstered studies that found that executive function levels could be improved over time (Waber, Gerber, Wagner, Forbes & Turcious, 2006).

The finding of a significant decrease in academic achievement for both groups was not supported in the literature and could be considered an anomaly due to testing conditions (St Clair-Thompson & Gathercole, 2006).

Further the mean academic achievement scores of the two groups did not show a statistically significant difference given consideration of the pretest covariate. This finding was not consistent with studies found in the literature, because improvements in executive function of the experimental group have led to an improvement in academic achievement in other studies (St

Clair-Thompson & Gathercole, 2006). This finding could be contributed to the posttesting conditions. Even with the significant improvement of the experimental group in the area of executive function, the mean executive function scores on the posttest were not shown to be statistically different.

The moderate but insignificant correlation finding between academic achievement and executive function was troublesome and not supported by the literature (Sarver, Rapport, Scanlan, Raiker, Altro, & Bolden, 2012). The literature suggests that one might find a strong correlation between academic achievement and executive function.

Implications of Findings

The significant finding of increased executive function levels in the experimental group provide a promising strategy for teachers to use. This study provides educational practitioners with a concrete group of executive function skills instruction that could help students to improve these critical skills. With continued use the skills improved by the Pomodoro Technique could possibly lead to improved achievement and life outcomes. This finding is consistent with those in the field of education. However, this finding should be interpreted with caution, given that the data failed to reveal a correlation between achievement and executive function. But, the promising finding of increased executive function levels of the experimental group of this study provides a foundation on which further research can expand and improve upon. It could also lead teachers to consider the inclusion of executive function skills instruction in daily classroom routines.

Limitations

The sample size was a limiting factor, and the restrictive nature of the pre-set classroom makeup could have had an impact on the results. For example, if more students in the control

group were intellectually gifted, the results could be skewed. The exact nature of the intellectual levels of the students in each group was unknown due to the fact that that data was not collected. Other grouping concerns could include students with IEPs, 504 plans, and English language learners. Ideally, these students should be heterogeneously distributed in the classes.

The length of the study was a limiting factor. The period of one nine-week grading cycle was potentially a reason for the failure to detect significant results. This time period occurred during the winter months and the weather also could have impacted the results. The weather's impact on the posttest achievement scores is potentially seen in the poor outcomes for both the experimental and control groups. This could also be accounted for by poor testing conditions. Interruptions, in the form of intercom announcements, and snow/sleet, could have interfered with students' concentration leading to off-task behaviors and potentially task shifting issues.

Recommendations

Executive function skills instruction should be the subject of further research. CCSS specifically and critical thinking skills in general require, for success, a well developed set of executive function skills. The current study indicates that the Pomodoro Technique could help students achieve higher levels of executive functioning in the classroom without much deviation from the normal classroom routine. Future research should include a wide variety of grade levels from elementary to post secondary, and include all student populations, heterogeneously mixed.

Additionally, future studies could benefit from using the actual Common Core State Standard assessment, which is administered under strict testing conditions. These strict conditions would better preserve the students ability to concentrate and perform near their potential.

Finally, future studies might benefit from a longer treatment period. Extending the length of the study skills instruction may be necessary to see significant improvements in academic achievement.

The potential benefits of improved executive function go well beyond that of improved academic achievement. They impact the quality of life a person can enjoy (Moffitt, Poulton, & Caspi, 2013). Therefore, this study illuminates the potential of improving executive function through specific skills instruction and interventions that future researchers should explore further.

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- Translating the culture of kids to the culture of education for the benefit of students, teachers and testing with the "Grannies from the Hood."

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