COGNITIVE TRAINING IN A SCHOOL CURRICULUM: A QUALITATIVE SINGLE INSTRUMENT CASE STUDY

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COGNITIVE TRAINING IN A SCHOOL CURRICULUM:

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ABSTRACT

COGNITIVE TRAINING IN A SCHOOL CURRICULUM:

A QUALITATIVE SINGLE INSTRUMENT CASE STUDY

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Stuart Andrew Musick

This qualitative case study examined practical, effective applications of implementing a cognitive training curriculum into a high school curriculum. The intent was to help students increase student achievement by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether. This study investigated how cognitive training can help both regular education students and students with disabilities. The notion of training or re-training the brain to think faster, more efficiently, and at higher levels was the focus of this research and the experiments that were discussed. The purpose of this qualitative case study was to examine practical, effective applications of implementing a cognitive training curriculum into a school with the intent of helping all students be successful. A cognitive training program was defined as any program that attempts to help a student learn faster, easier, and better (Hill, 2012).

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sacrifices, positive support, and encouragement to help me be the man, the husband, and the father that I want to be.

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Chapter I

Introduction to the Study

In a qualitative single instrumental case study (Stake, 1955), the researcher focuses on an issue or concern, and then selects one bounded case to illustrate that issue (Creswell, 2013). In this qualitative single instrumental case study, the researcher focused on the issue of how to improve student achievement in a public school setting. The study examined not only how we learn, but how to increase our capacity to learn effectively. This topic reached across a global community of learners. It was an area of interest that is not limited by national origin, race, or culture, but can be beneficial to anyone that desires to improve learning.

The study examined practical, effective applications of implementing a cognitive training curriculum into a high school curriculum. The intent was to help students increase student achievement by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether. This chapter of the study was organized by background, problem statement, theoretical considerations, purpose statement, research questions, rationale for the study, assumptions, limitations, delimitations, key terms, and the summary of the chapter.

In a time where school districts are held to higher accountability standards than ever before, many districts may be interested in investing monies toward a program or programs that will effectively increase their student success in the classroom and on standardized tests (Texas Education Agency, 2011). However, it is also important to note that those same school districts and systems are being required to stretch their budget

further than ever before and do more with less funding (Stutz, 2013). This study will be conducted using a qualitative design methodology to gather data on the use of brain-training with all high school students in grades 9-12 at a small 3-A rural school district located in East Texas.

Background

A key target of cognitive training research is how it can help learners learn more effectively (Hill, 2012). The notion of training or re-training the brain to think faster, more efficiently, and at higher levels is the focus of this research and the experiments that will be discussed.

The Cognitive training industry is a multi-million dollar industry (Sparks, 2012). Cognitive training, including training working memory, has been influenced by the increasing number of researchers and studies in the field of neuroplasticity. Sparks (2012) cited the San Francisco based market research SharpBrains to indicate that between 2005 and 2009, the cognitive training industry increased 31 percent to 295 million dollars. SharpBrains stated that just over half of the money spent during that time frame, 148 million dollars, came from the United States.

Figure 1 below illustrates a mind map exercise that included just some of the different areas of brainstorming when considering all of the endless directions that cognitive training could be considered.

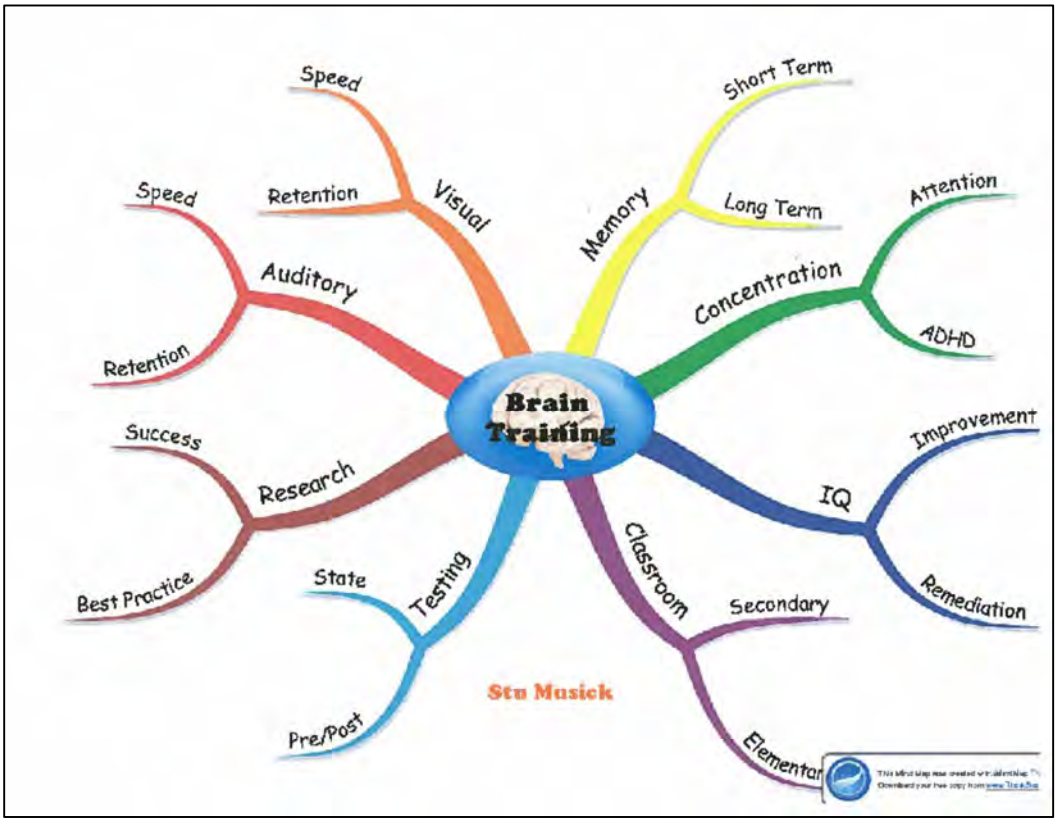

Figure 1. Brain Training Mind Map.

Whether you are an adolescent, a young adult, middle aged, or elderly, there are ways that you can keep the brain active and improve your brain's health (Willment, 2014). The author stated that individuals are encouraged to not only exercise for their physical health, but for their mental health, as well. As people engage in physical activities to increase cardiovascular health and improve muscle strength, they are also encouraged to do mental and cognitive activities that exercise the brain (Aamodt & Wang, 2007). People are also asked to choose not only mental activities, such as tricks to help remember people's names or lists, but also to select computerized activities that stimulate the brain to think and practice (Willment, 2014).

In Willment's (2014) article, she stated that such exercises can even have beneficial effects that last up to ten years. Willment (2014) went further and stated that small activities such as reading and crossword puzzles can even have a beneficial effect. She recommended increasing your concentration and attention levels by using programs that use computerized training and teach strategy skills.

The Center for Brain Health lists brain research and cognitive training being used in studies in a wide range of fields including addictions, Alzheimer's disease in older adults, Attention Deficit Hyper Activity Disorder (ADHD), Autism, Mild Cognitive Impairments (MCI), brain injuries, as well as military personnel and Post Traumatic Stress Disorder (PTSD) (Klingberg et al., 2004). Cognitive training exercises are also being used in athletes for both performance improvements and in the area of concussions and how they affect the brain (Ulfarsson, 2014).

In our schools, money is spent each year in the areas of remediating students that are behind their peers in subjects including math, science, and reading (Stutz, 2013). There are many ways that schools may go about narrowing those learning gaps including tutorials, software programs, additional staff for smaller student-teacher ratios, and assessments to determine what areas the student may be lacking (Rode et al., 2014). Hiring a tutor may help when a student did not understand a concept when it was taught the first time. This may be caused by distractions or other interfering factors to the learning or even the teaching (Heron, 2010). If a student continues to struggle with learning, there may be a need for cognitive training to identify and target the needed area of learning difficulty (D. Walker, personal communication, September, 2014).

Problem Statement

Whether you are a classroom teacher or a coach, both look for ways to increase student, or student-athlete, success. The same is true as an administrator. No matter what the role or what the title may be, educators seek the most effective strategy to increase learning (Stutz, 2013). There are numerous companies or organizations that claim that their software or their packages are the way to go (Bryan, 2014). The concern for the public school administrator with little or no money to spend in additional areas is how they can get the most bang for their buck to help their students succeed (Rode et al., 2014).

In a time where school districts have decreased revenue and funding from the state, many districts have decreased staffing which leads to larger classes (Stutz, 2013). The question then becomes how we can effectively and efficiently utilize our programs and our personnel to maximize student success. The cognitive training industry is a multi-million dollar industry (Aamodt & Wang, 2007) that is focused on their profits. That conflicts with the goal of schools that are focused on cutting costs while still maintaining student success (Stutz, 2013).

Theoretical Considerations

Starting in the early 1960's, Dr. Paul MacLean introduced the concept that we do not just have one brain, but three. The Triune Brain Theory holds to the concept that the brain acts as three separate areas that include the Reptile Brain responsible for base drives, the Mid Brain that is essentially responsible for emotions and memory, and the Neocortex responsible for higher levels of brain functions (MacLean, 1990). While the Triune Brain is still used as a model for research, most modern neuroscientists have

moved past the original thought of the brain as three separate brains and consider that thought as outdated (Reardon, 1999). Today, developmental biologists look to the brain as much more complex, even in the most simple of animals (Deutsche, 2003).

In an article published in July, 2014, researchers at the University of Montreal discussed targeting specific brain exercises to bring about specific, desired results (Belleville, 2014). Belleville (2014) stated:

> Our work shows that there is also an association between the type of cognitive training performed and the resulting effect. This is true for healthy seniors who want to improve their attention or memory and is particularly important for patients who suffer from damage in specific areas of the brain. We therefore need to better understand the ways to activate certain areas of the brain and target this action to get specific results. (p. 8)

Part of the research highlights the effects of cognitive training exercises and how it may help with multi-tasking. The researches state that the ability to effectively multi-task decreases with age, but this decline may be slowed, or even reversed, with cognitive exercises (Belleville, 2014).

Recently, results from an 11 year study on brain injury were produced that show the follow up data from individuals that received cognitive training therapy to treat the brain injuries they had incurred (Ulfarsson, 2014). The research showed that the treatment results were directly and positively related to how quickly the individual received the cognitive training regiments during their recovery (Ulfarsson, 2014). Ulfarsson (2014) also stated that the patient's chances of survival were also directly and positively affected by the cognitive training. According to the results of the study,

Ulfarsson (2014) believes that immediate cognitive training could increase long-term survival. However, he also stated that deciding factors for recovery included admission to rehabilitation support at the right time, special interventions for patients who were unemployed or on sick leave prior to the injury, and assessment of pituitary function in overweight patients (Ulfarsson, 2014).

In her recent study, Dr. Lori Bryan (2014) stated:

> In less than 20 years, an underlying tenet in neuroscience that the brain does not change beyond early childhood has undergone a radical shift. It has been demonstrated that not only can the brain change, but it is capable of doing so throughout the life span. (p. 2)

She goes on to explain that cognitive training can have positive effects on the attention span, working memory, visual and auditory processing speeds, logic, and reasoning (Bryan, 2014). She concluded by saying that a biological basis supporting quality, effective cognitive training programs is supported by the discovery that physical changes in the brain can and do occur across a person's lifespan (Bryan, 2014). She also stated that areas of cognitive skills that were weaker could be strengthened with the appropriate cognitive training including measureable improvements in intellectual ability (Bryan, 2014). This theoretical statement was the framework for this study.

Purpose Statement

The purpose of this qualitative case study was to examine practical, effective applications of implementing a cognitive training curriculum into a school with the intent of helping all students be successful. By using cognitive training programs in the classroom, the intent of helping high school students increase student achievement may

be realized by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

A cognitive training program was defined as any program that attempts to help a student learn faster, easier, and better (Hill, 2012). The research focused on targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

Research Questions

The following research questions guided this study:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
2. What components of online computerized cognitive training are perceived as practical and effective?
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?

Rationale and Significance of the Study

There is still much debate that needs to be researched to challenge whether or not cognitive training actually works (Sparks, 2012). Sparks (2012) stated that more importantly, it is crucial to challenge specific companies and cognitive training activities to see which ones actually do work and are worth the money spent on them. In a time where school districts are held to higher accountability standards than ever before, many districts may be interested in investing monies toward a program or programs that will effectively increase their student success in the classroom and on standardized tests

(Stutz, 2013). However, it is also important to note that those same school districts and systems are being required to stretch their budget further than ever before and do more with less funding (Sanchez, 2011).

Assumptions

In this section, philosophical assumptions behind qualitative research were analyzed beginning with determining where assumptions fit within the overarching process of research in general (Creswell, 2013). Assumptions utilize abstract beliefs and ideas in order to inform the researcher. Creswell's (2013) study utilized the epistemological approach. Therefore, the subjective evidence and information was collected based on individual views of the experiences gathered from an interview process. The following assumptions have been considered prior to this study:

1. Those interviewed were open and honest and participated fully with their discussion and answers during the interview process.
2. The documents included in the study and data analysis were reflective of accurate information and data for the study.
3. Learning difficulties are caused by cognitive weakness.
4. Learning, thinking, and reading are based in cognitive skills.
5. Students participated fully in the activities designed to improve cognitive skills throughout the course of the study.

Limitations

Limitations to the research are considerations that could affect the outcome of the data and the study. These could potentially reduce the quality of the findings (Creswell, 2012). This study was designed to investigate student cognitive improvement in the local

setting. It only involves high school students in a single small rural district in Texas. The following limitations have been considered:

1. Students may not take the remediation (cognitive training) course seriously and not put forth 100% effort into the cognitive training exercises.
2. Those being interviewed may or may not answer all questions openly and honestly.
3. The data collection and interviews took place three years after the study had been completed.
4. Only one 45 minute period a day was set aside for cognitive training and it might not be sufficient time to show maximum results.
5. The documents collected may not include all relevant information to get an accurate representation from a single case study.
6. The researcher was a participant as an observer and not fully and directly immersed into the daily cognitive training activities that took place in the classroom.

Delimitations

A delimitation is a factor that could potentially affect the study, but is controlled by the researcher (Creswell, 2012). The following delimitations to the study were factors controlled by the researcher:

1. The cognitive training exercises that took place were not directly related to a specific content area.

2. The brain-training sessions were scheduled into the students' daily schedule in a 45 minute class period and may be more successful if given longer training periods.
3. This study was performed among high school students in grades 9 through 12, ages 14 through 19, and may be more effective with a different age group or level.
4. The study was performed at a rural, 2A high school curriculum.

Definitions

It is important to define some key terms that will emerge throughout the review of literature.

- *Neuroplasticity* is defined as the capacity of the nervous system to develop new neuronal connections (Heron, 2010).
- *Fluid Intelligence* describes how the brain uses the ability to perceive relationships independent of previous specific practice or instruction concerning those relationships (Mather & Jaffe, 2002). Fluid intelligence includes the ability to think and to reason in abstract manners in order to problem solve.
- *Crystallized Intelligence* which includes knowledge and learning from both prior and past experiences (Blackwell, 2002b).
- *Working Memory* is defined as the ability to retain information during short periods of time. The working memory capacity is the maximum amount of information that an individual can recall or retain. This is important in the areas of problem solving and reasoning (Westerberg & Klingberg, 2007).

Summary

In Chapter I, the researcher introduced the study with the background and purpose statements, as well as the significance and rationale for the study. Chapter II includes a review of relevant literature related to the study. Chapter III addresses the research methodology which includes the population sample and description of the interviews, observations, data collection, and procedures used in the study. Chapter IV presents the findings of the data collection and the data analysis. Chapter V contains the conclusions, implications, and recommendations for future research.

Chapter II

Review of the Literature

The purpose of this research was to examine practical, effective applications of implementing a cognitive training curriculum into the Waskom High School classrooms with the intent of helping all students succeed (Sparks, 2012). Student success, or student achievement, included six-week grades, semester grades, observations, and interviews among staff. A cognitive training program was defined as any program that attempted to help a student learn faster, easier, and better (Hill, 2012). The research focused on targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

In the following sections, there will be a description of the area of cognitive science known as Neuroplasticity. Next, there will be an examination of the different areas of cognitive thinking that current research has examined to look into the effects of training the brain. The areas of cognitive development explored include: training working memory, visual processing levels, and auditory processing levels. Areas of growing intelligence include both pre-frontal activity and parietal activity. The section of fluid intelligence will examine both temporal dynamics and spatial dynamics. Next, will be an analysis of cognitive training practices in the classroom setting. In looking at the relationships between reasoning and comprehension, both inductive reasoning and deductive reasoning were analyzed. Finally, there is an exploration of research and literature that is available that examines the effects of cognitive training on general education students, as well as, students with various disabilities. This will include examining levels of student success in students with Attention Deficit Hyperactivity

Disorder (ADHD), stroke victims, poor readers, and how age differences can be a factor in learning.

Theoretical Considerations

In 2011, Laurence Hirshberg wrote, "Perhaps the most important neuroscience finding of the past 15 years is the recognition that the brain is constantly reorganizing its function, redeploying available resources to meet life's demands for adaptation" (p. 1060). Researchers in the field of neuroscience are looking at ways to develop treatments for both mental and behavioral health concerns that include training, or re-training, the brain to connect more effectively and more efficiently with the firing of the neurons (Hirshberg, 2011). Hirshberg described how it is considered that not only are new pathways created between neurons, but also the development of new neurons themselves due to cognitive development and training.

Lane and Schaaf (2010) described the brain's ability to be developed through training. They further discuss how neuroplasticity, the neural structure of the brain, and the neural function is impacted by the environment. Lane and Schaaf concluded that changes in cognitive development and behavior can be task specific. Therefore, it is important to remember that the researcher should be "focused in terms of outcome measures" (Lane & Schaaf, 2010, p. 377). Lane and Schaaf's findings were congruent with Stoekel et al., (2004) which stated that some changes in cognitive ability can be significant and long lasting depending on the environment and each individual person.

Starting in the early 1960's, Dr. Paul MacLean introduced the concept that humans do not just have one brain, but three. In his research, MacLean's Triune Brain Theory states that the brain acts as three separate areas that include the Reptile Brain

responsible for base drives, the Mid Brain that is essentially responsible for emotions and memory, and the Neocortex responsible for higher levels of brain functions (MacLean, 1990). While the Triune Brain is still used as a model for research, most modern neuroscientists have moved past the original thought of the brain as three separate brains and consider that thought as outdated. Today, developmental biologists look to the brain as much more complex, even in the most simple of animals (Deutsche, 2003).

Neuroplasticity

Often, when people think about intelligence, they presume that to a degree, it is either something that you are born with or without (Blackwell, 2002b). However, new research has shown that not only does the brain act much like a muscle, but it can actually develop and grow as we use it and train it (Blackwell, 2002b). Activity between the neurons within the brain enables humans to think (Hirshberg, 2011). According to Hirshberg (2011) as humans think more, and think at higher, more complex levels, brain cells seem to grow. Studies among animals that have been engaged by activities, toys, and stimuli have actually increased their brain mass by as much as 10% more than animals that have lived with little to no stimuli or activities (Blackwell, 2002a).

Neuroplasticity is often referred to as brain plasticity (Cobarrubias, 2014). It involves the processes in which the brain's neural pathways and synapses are affected and possibly altered as an effect of behavioral, environmental, and neural changes (Cobarrubias, 2014).

Areas of Cognitive Development

According to Baddeley (1998), working memory is the ability to “maintain and manipulate information, particularly in the presence of distraction, and depends critically

on attentional control" (p. 4). When a student enrolls or enters public education, school district personnel check their eyes and their ears to see if there are any audible or visual deficiencies (D. Walker, personal communication, September 2, 2012). However, school personnel do not check or test their brains and their cognitive levels to measure or diagnose any levels of cognitive deficiencies (D. Walker, personal communication, September 2, 2012). This is the most vital organ that impacts student development and student success (D. Walker, personal communication, September 2, 2012). There has been a common myth in education whereby people think that a student's readiness to learn and the ability to process information are genetically pre-determined or that their Intelligence Quotient (IQ) is a fixed quantitative number (D. Walker, personal communication, September 2, 2012). The cooperating mindset to this line of thinking is that the only solution is to accommodate or make modifications to the curriculum to fit the student's special needs (D. Walker, personal communication, September 2, 2012). According to the National Assessment of Education Progress, approximately 33% of 4th and 8th grade students are proficient in the area of reading (Hernandez, 2012). Also, out of the economically disadvantaged students who qualify for the school lunch program, approximately half of those students perform worse as a group with approximately 20% that are considered to be proficient in reading (Hernandez, 2012).

Training working memory. The possibility has been raised by recent advances in neuroplasticity, that cognitive health may be optimized and have longer lasting effects by engaging in training exercises that are specifically designed to target basic cognitive mechanisms (Gibson et al., 2013 p. 726). This line of thought goes hand in hand with the physical activity of training the body to make the muscles get bigger and stronger. The

findings of this recent study raised the possibility that the working memory may be increased by targeting specific areas of the brain through cognitive exercises (Gibson et al., 2013).

A recent 2014 study raised the question of whether or not training working memory can be effective in a traditional school setting (Rode et al. 2014). The study compared third graders that were divided into two groups. The control group was given regular classroom task activities, while the experimental group was given 30 minute computerized training activities. Following pre-test, training sessions, and post-test, results indicated that while there were strong gains in the training tasks that were practiced. These training tasks were also relevant to the ability to transfer that learning over to traditional tasks (Rode et al., 2014). However, the results were not consistent across the varying tasks which raised a level of concern as to whether or not the training tasks would be effective in a school, classroom setting.

Visual processing levels. It is common that age related declines in not only an individual's vision, but also their visual processing speeds should be expected (Wollinski et al., 2013). In 2013, a study was performed to see if those age related declines could be slowed, stabilized, or even reversed. After cognitive training in middle aged and older adults, there were significant signs of both stabilization and even improvement that occurred in an individual's visual processing speeds after undergoing cognitive training (Wollinski et al., 2013).

In 2010, Lupyan and Spivey, conducted research to test whether or not seeing visual cues would enhance or increase one's ability to perceive visual stimuli. The study would start by showing each individual a symbol and then test whether or not they could

visibly recognize that symbol in a set of visual cues. The researchers concluded that there was no indication that seeing a visual cue prior to the test increased the ability to visually see or perceive the symbol following the cue (Lupyan & Spivey, 2010).

Auditory processing levels. In a recent 2013 study, Lavie et al., attempted to examine if listening training could improve the hearing in hearing aid patients. Two study groups underwent the listening training both with and without the aid of their hearing aid devices. Results showed improvement in hearing without the aid of their listening device and even showed significant improvement further along after the study was completed. "The improvement of unaided dichotic listening scores suggests that hearing aid use contributes to auditory processing even for unamplified input, presumably through neuroplasticity. The semi-structured listening experience (listening training) seems to have had an additional beneficial effect", (Lavie, Attias, & Karni, 2013, p. 348).

In the 2010 Lupyan and Spivey study, the researchers also conducted a study to test whether or not hearing an auditory cue would enhance or increase one's ability to see a visual cue. The study included giving each individual an auditory cue to allow them to hear a letter, a word, or a symbol and then test whether or not they could visibly recognize that symbol in a set of visual stimuli. The researchers concluded that there was significant indication that hearing an auditory cue prior to the test increased the ability to visually see or perceive the symbol following the cue stating, "Hearing a word made otherwise invisible objects visible." (Lupyan & Spivey, 2010).

Growing Your Intelligence

Blackwell (2002b) discusses the effects of learning new information and how it affects the brain, the brain's capacity, and the brain's ability to grow. The author

highlights that as an individual learns new things the nerve cells and connections in the brain actually multiply and, therefore, get larger. The study also showed that animals that lived in an environment with activities, items to play with and use on a continual basis, and continual stimuli had brains that were up to 10% heavier than animals that lived in an environment with little or no stimuli.

Pre-frontal activity. In 2004, a study was performed to examine how different parts of the brain could be affected by cognitive training. Olesen, Westerberg, and Klingberg (2004) concluded that the brain could be trained and levels of learning improved by intensive training. The study showed a positive correlation between the cortical pre-frontal activity in the brain and working memory capacity. Also, a positive correlation was found between activity that is related to working memory and general fluid intelligence.

A 2014 study of the effects of Cognitive Remediation Therapy (CRT) upon the pre-frontal and medial portions of the brain indicated that Cognitive Remediation Therapy shows promise as a treatment for cognitive impairments (Thorsen et al., 2014). The researchers stated that neural mechanisms that are targeted by CRT are not completely known, but a possibility is that the guidance and use of cognitive training strategies protects the remaining neurobiological and cognitive resources by strengthening the compensatory structures. CRT is also believed to promote the growth and strength of new connections through neuroplasticity (Thorsen et al., 2014).

Parietal activity. The 2004 study by Olesen, Westerberg, and Klingberg also showed a positive correlation between activity that is related to the working memory of the brain, fluid intelligence, and the MRI amplitude in the frontal-parietal network that

relates to successful tasks dealing with working memory activities. The authors went on to state that the brain's plasticity may be the reason for the increased activity that is brought on by working memory tasks associated with training exercises.

Research has indicated that Cognitive Remediation Therapy (CRT) not only affects the pre-frontal region of the brain as mentioned above, but also affects several brain regions and brain circuitry, including parietal and limbic areas, both in terms of activity and structure (Thorsen et al., 2014). The authors stated that neural changes from cognitive training were also accompanied by improvement in neurocognitive performance, which strengthens the relationship between the behavioral changes and the neurobiological changes.

Dehaene et al. (2003) studied the direct relationship between the parietal lobe number processing, and in particular, with the manipulation of numbers, such as in comparison or approximation. Individuals with lesions or other parietal abnormalities have been known to suffer from difficulties in number processing (Dehaene, Dehaene-Lambertz, & Cohen, 1998). Also, the left parietal lobe, specifically, is also believed to be responsible for single letter processing (Kuhn et al., 2011). The Kuhn et al., (2011) study reveals that the parietal region is directly related to successful memory, suggesting that improvements resulting from cognitive training might even contribute to improvements in decision-making.

Fluid Intelligence

Blackwell (2002a) indicated that fluid intelligence can be improved by repeated practice of specific activities. However, the author stated that there had been no indication that the learning could transfer to other areas of learning and skills that were

not specifically related to the practiced behaviors. However, a recent study in 2008 by Jaeggi, Buschkuehl, Jonides, and Perrig gave an indication that contradicts the previous studies and findings by claiming that learning can be transferred to unpracticed tasks and behaviors. Furthermore, the study indicates that multiple level tasks can be improved upon through cognitive training strategies.

Temporal dynamics. Temporal dynamics can be considered the interaction of different regions of the brain as it reacts to varying musical and rhythmic sounds (Draganski et al., 2006). Draganski et al., (2006) indicated that the brain has the ability to grow as cells multiply which increases gray matter within the brain. The researchers go on to state that the brain's plasticity can be viewed as an evolvement for coping with changes in the environment. Their results support theoretical considerations that stress how structural forms of neuroplasticity are important for processing information in dynamic networks according to new demands (Chambers, 2004).

A 2008 study on the effect of intensive cognitive mental training revealed that mental processes are malleable skills that can be trained through cognitive mental training exercises (Slagter et al., 2009). The researchers also stated that positive effects of training of various lengths and in a variety of styles have also proved successful on various mental skills. The current data from Slagter, et al. (2009) suggested that cognitive training can have an effect on how the attention span and resources are affected.

Spatial dynamics. The study of Draganski et al (2006) examined how different presentations of visual learning would impact the increase or decrease in both white and gray matter in the brain. These different presentations affected the spatial dynamics or

how the brain perceives and interprets the material. The study showed an increase in brain cell size both during and following the cognitive trainings.

Friedrich, Neuper, and Scherer (2013) performed a study asking users to perform mental tasks while their multi-channel EEG was recorded. The tasks performed included mental rotation, word association, auditory imagery, mental subtraction, spatial navigation, motor imagery of the left hand and motor imagery of both feet. The researchers describe the process of a Brain-Computer Interface (BCI) translating physiological brain signals from the subject into an output reflecting the user's intent to be displayed on the computer. Friedrich, Neuper, and Scherer (2013) stated that the BCI "can provide severely motor-impaired users with a new, non-muscular channel for communication and control which may be their only possibility to interact with the external world" (p. 76214). The researchers go further to describe how BCI research is also gaining attention for non-medical applications, such as gaming, art, and cognitive monitoring of brain activity.

Relationships Between Reasoning and Comprehension

Another recent study conducted by Mackey et al., (2011) compared the effects of reasoning and cognitive speed training in children ages 7-10 from low-socio economic backgrounds. The students participated in an afterschool program for 75 minutes per day, two days per week, for eight weeks. Here, the students participated in numerous computer based games and activities to test their reasoning skills and their processing speeds. All games are available for purchase and download at bigfishgames.com. Computerized: C; Non-computerized: NC; NintendoDS: DS; Indiv.: Individual. Games selected for reasoning training demanded the joint consideration of several task rules,

relations, or steps required to solve a problem. Games selected for speed training involved rapid visual processing and rapid motor responding based on simple task rules (Mackey et al., 2011). Both programs led to significant gains in cognitive skills.

An earlier study by Roberge and Craven (1982) compared developmental relationships between reading comprehension and deductive reason in 5th through 8th graders. The student scores on the reading test were collected and analyzed on the following three categories: grade level, reading comprehension, and level of logical rule. There were conflicting results from one grade level of students to the next. For example, while patterns of comprehension and improvement existed for one grade level, the opposite pattern would be true for a different grade level. While Roberge's findings did not resolve the current debate during that time period between reasoning and comprehension, the study did "highlight the interdependence between language skills and the ability to reason in a hypothetico-deductive manner" (p. 6).

Inductive reasoning. In their 2010 study, Heit and Rotello stated that inductive reasoning may be based on observations. The authors went on to state that individuals that use inductive reasoning may find patterns in a collection of observations and draw a general conclusion based on those patterns. Inductive reasoning is used typically by social scientists conducting qualitative studies. Heit and Rotello (2010) showed that inductive reasoning is more affected by similarities.

The Concept Formation subtest, used at both pre-test and delayed post-test, is used to gauge an area of fluid intelligence by measuring inductive logic and executive processing (Mather & Jaffe, 2002). The test requires individuals to identify, categorize, and determine rules via the cognitive processes of categorization, rule switching,

induction, and inference (Schrank, 2006). The test taker is presented with a complete stimulus set, and then they must derive and apply a rule to each item. The Concept Formation subtest is a controlled learning task. Therefore, constructive feedback is provided throughout the administration of the task before a new item is presented to the individual taking the test (Mather & Jaffe, 2002).

Inductive reasoning is a core cognitive process of fluid intelligence that is able to predict a variety of outcomes educationally (Barkl, Porter, & Ginns, 2012). In her 2012 article, Sophie Barkl discusses The Cognitive Training for Children (CTC) program. The author describes the CTC program as an educational intervention designed to develop children's inductive reasoning skills. The researchers also noted the significant effects of the program on both inductive reasoning ability and classroom learning. The author described a recent study that assessed both individual and small-group CTC cognitive training groups versus a control group that received no additional training to investigate the effects on inductive and deductive reasoning and mathematics achievement. The study showed that students who received individual cognitive training activities achieved significantly higher than those in the control group on measures of inductive and deductive reasoning (Barkl, Porter, & Ginns, 2012). Those students in the small-group condition were also found to outperform the control group significantly on a measure of inductive reasoning three months following cognitive training.

Deductive reasoning. In their 2010 study, Heit and Rotello suggested that deductive reasoning is based on laws or general principles. The authors continue on to state that someone that uses deductive reasoning may do so by applying a general principle to specific examples. A scientist that is conducting laboratory research may

rely heavily on quantitative reasoning to test their hypotheses (Heit & Rotello, 2010). That same study by Heit and Rotello (2010) showed that deductive reasoning is more affected by validity. They also stated that "fast deduction judgments were like induction judgments—in terms of being more influenced by similarity and less influenced by validity, compared with slow deduction judgments."

Mather and Jaffe (2002) noted that the Analysis Synthesis subtest measures an area of fluid intelligence by focusing on an individual's deductive reasoning ability. The researchers also stated that deductive reasoning ability is the ability to reason and draw conclusions from a given stimulus. The test requires the participants to analyze puzzles using symbolic formulations to determine missing components using the individual's cognitive processes of algorithmic reasoning and deduction skills (Schrank, 2006). The Analysis Synthesis subtest is also a controlled learning task. Therefore, corrective feedback is provided throughout the administration of the task before a new item is presented to the individual, as in the Concept Formation subtest mentioned above regarding inductive reasoning (Mather & Jaffe, 2002).

Changes in Student Levels of Success

From Westerberg and Klingberg's (2007) definition, working memory is defined as the ability to retain information during short periods of time. The working memory capacity is the maximum amount of information that an individual can recall or retain. This is important in the ability to problem solve in addition to the area of the ability to reason.

In their 2007 study, Westerberg and Klingeberg had individuals practice working memory activities over a period of five weeks. The exercises included repetitive training

with increasingly more difficult levels of practice. A recent study has shown that this type of training has been especially effective for adolescent children with Attention Deficit Hyperactivity Disorder or ADHD (Westerberg & Klingberg, 2007). Their study charted the progress of three subjects during the study and then compared to the progress of a control subject.

Jaeggi, Buschkuehl, Jonides, and Shah (2011) stated that fluid intelligence is dependent on a student's improvement in working memory. "There is also concern that students that do not show marked improvement in skills are due to the fact that they are already performing at or near their ceiling capacity" (Jaeggi et al., 2011, p. 6829). This thought goes against the line of thinking that the brain can continually be improved as a muscle and increases made. However, even physical trainers will tell you that the muscular system has a ceiling or max point for improvement due to training (B. Bobo, personal communication, 2006).

Studies of functional imaging have demonstrated on a consistent basis that students with reading disabilities have fewer areas of brain connection activities that are stimulated during reading (Keller & Just, 2009). The specific areas of deficit activity in the brain include the occipital-temporal, temporo-parietal, and inferior frontal cortical regions. The same studies have also shown that effective practices of reading interventions can lead to increased cortical activities in those same areas. One longitudinal study by Keller and Just (2009) indicates that approximately 100 hours of intense remedial reading intervention and instruction can effectively change the structural integrity of the brain's white matter in students that are considered to be poor readers.

Case Studies

The following section includes case studies involving cognitive training. The section has case study information regarding students with Attention Deficit Hyperactivity Disorder (ADHD), cognitive training in the work with stroke victims, training involving poor readers, and case studies on age differences. The section concludes with information from the 2011-2012 National Science Foundation research project.

Students with Attention Deficit Hyperactivity Disorder. "Childhood Attention Deficit Hyperactivity Disorder (ADHD) is a growing mental health concern worldwide" (Mishra et al., 2013, p. 38). Due to this growing concern, there is a need for cost-effective and accessible treatments for students with ADHD. This 2013 study by Mishra et al., examined how a web-based cognitive training intervention called Online Neuroplasticity-based Training for the Remediation of ADHD in Children (ONTRAC) (Mishra et al., 2013). This software could be accessible both at school and at home and was found to incrementally improve student performance in various areas of cognitive deficiencies among children with ADHD.

The authors state that currently 10% of children are diagnosed worldwide with ADHD. Evidence points to that percentage increasing in the future even to the point of reaching an epidemic level of concern (Mishra et al., 2013)

In 2005, a study was conducted by Klingenberg et al., using 53 children ranging in age from 7-12 years old. Each of the subjects was diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). Cognitive training was done on the children over a period of period of five weeks. A pre-test was given before the training and after the

training was completed both a post-test and a follow up post-test were given. Results showed that the working memory tasks of the students showed a significant increase while the inattentive behaviors showed a significant decrease both during and after the training took place (Klingenberg et al., 2005)

Stroke victims. In 2007, Westerberg et al. performed a pilot study to see if there was a possibility of increased learning in adult stroke victims. The study measured working memory in adult victims of strokes more than a year after suffering the stroke. The results of the study included decreased problems that affected both working memory and attention in patients that underwent the cognitive training. Also, there were significant improvements from pre-test to post-test results showing an increase in working memory and improved attention spans.

A 2008 study performed at the Johns Hopkins University School of Medicine showed that stroke victims can actually train the brain while also training the body using treadmill exercises (Hanley et al., 2008) The study's results showed that patients are capable of "rewiring the brain months, or even years, after suffering from a stroke." (Hanley et al., 2008, p. 64). The experimental group underwent daily treadmill exercises with assistance, if needed. Gradually, over time, the physical therapists would increase both the speed and the incline for the treadmill patients. The control group participated in daily stretching exercises alone. Both groups participated in a pre-test and post-test function magnetic resonance imaging (fMRI) to analyze brain activity during activities. The treadmill group showed significant differences in their improvement in the areas of walking speed and their aerobic capacity, as well as, significant improvement in their post-test fMRI results. Hoping that evidence would show that improved brain activity

was responsible for the result differences, the researchers analyzed the brain scans and found significantly increased metabolic activity in brainstem areas associated with walking among each of the experimental treadmill exercisers. In contrast, the brain scans of the patients in the control stretching group showed no such improvements. Results showed that the patients with the most improvement in walking also showed the strongest change in brain activity.

Poor readers. Keller and Just (2009) conducted a study that examined how the brain activity of poor readers could be affected and improved by intensive cognitive training. Certain regions of the brain were identified in poor readers that were far less advanced than those of students that could read well at the same ages. Results indicated that the white-matter regions of the region of the left anterior centrum semiovale could be significantly affected by intense remediation that results in improved reading levels.

Differing approaches to remediation of students with reading disabilities are also affected by our cognitive thinking ability (Holden, 2004). Phonics is a method of teaching reading by separating words into their component sounds. In contrast, the whole-language approach focuses on less rigid strategies for reading and focuses more on the process of reading and writing and encourages students to decode words in reference to the stories that they write. Holden (2004) articulated the eight month study from Yale University that concludes that tutoring students using the phonics approach actually changes the way that the brain operates. Brain images of those phonics students revealed substantial normalization of the brain's reading pathways (Holden, 2004). Particularly, brain scans showed more activity in areas of that recognize words without having to go through the process of deciphering.

Gaskins and Baron (1985) researched the different areas of difficulty that many poor readers share in common. The researchers identified four areas of factors that affect thinking, reasons for using strategies, methods of self-direction, and cognitive strategies. Gaskins and Baron (1985) stated that remedial programs will be of little use if the students did not possess basic skills and strategies that are necessary to complete specific tasks. In the study, some of the tasks that were modeled included the use of mnemonic devices, problem solving, hypothesizing, and imagery. In the eight month study, students were provided a tutor/mentor that modeled the characteristics and task skills needed to improve reading. The researchers summarized by stating that while the students benefited from having the one-on-one mentor tutor, there was also a desire to put those skills to use resulting from the positive feedback and support that they received. Gaskins and Baron (1985) concluded that a classroom curriculum should be composed of two parts: 1) teaching and modeling the facets of the cognitive training program to the class as a whole, and 2) weekly supplemental training with a one-on-one mentor instructor or tutor.

Age differences. A recent study has shown that age differences can dramatically affect an individual's ability to learn by linking their ability concentrate (Ball, 2010). Younger children under the age of eight do not have the attention span or the ability to block out surrounding distractions that negatively affect their learning, as well as, their memory. In between the ages of 8-13, children begin to develop a capacity to concentrate harder and begin to ignore distractions. However, it is not until an individual becomes a young adult to older adult that this ability is fully realized (Wendelken et al., 2011).

Kadosh, Linden, and Lau (2013) researched the potential of combining two recently developed behavioral and neural training techniques known as cognitive bias modification and functional magnetic neuroimaging-based neuro-feedback. The researchers discussed how combining the two lines of thought into a research approach could help reach the full potential of increased levels of plasticity during childhood and adolescence. In their conclusions, the researchers discussed how the combined approach could see multiple benefits. First, the research could provide significant insights into the manageability of developmental trajectories in a specific cognitive function, such as the processing of emotions. Furthermore, an improved understanding of the changes in behavior and brain functions will further the research on how we learn from cognitive training (Kadosh, Linden, & Lau, 2013). This research would be of interest to further study in both early developmental functions and mature functions alike. Finally, the research could help educators to identify sensitive developmental windows and identify when and where intervention approaches would prove to be most effective (Kadosh, Linden, & Lau, 2013).

Rothlisberger et al. (2012) study how small-group interventions in both pre-kindergarten and kindergarten classrooms can positively effect learning outcomes of five and six year old students. The study focuses on the basic components of executive functions in children including working memory, interference control, and cognitive flexibility. A total of 135 students enrolled in Swiss prekindergarten (5-year-olds) and kindergarten (6-year-olds) were involved in the research study. The results showed that the small-group remediation produced gains in all three components of executive functions. Pre-kindergarten students significantly improved their working memory and

cognitive flexibility processes, while significant training effects were found for the kindergarten children.

Cognitive Training in the Classroom

Over the past several years, a cross-disciplinary team of researchers from the Departments of Psychology and Biology at Virginia State University has been investigating the efficacy of cognitive training interventions for improving the mathematics performance of students at both the secondary and post-secondary levels (Hill, 2012). The National Science Foundation study results suggest that the best predictors of student performance in algebra are cognitive skills related to working memory, and that these cognitive skills can be improved using cognitive training interventions (Hill, 2012).

During the 2011-2012 academic year, this team of researchers conducted a study comparing three groups of students at Waskom High School in Waskom, Texas. The first group of students was the control group that had no change in schedule and continued with the regular classroom setting of curriculum and instruction. The second set of randomly chosen students consisted of approximately 100 students that were scheduled into a Cognitive training class period of 47 minutes where they used cognitive training exercises and activities from a computer-based program known as BrainSkills. Finally, the third set of randomly chosen students was also scheduled into a Cognitive training class period of 47 minutes. However, this set of approximately 30 students used a program of 1-1 brain trainers that worked individually with students from LearningRx cognitive training interventions.

Students from each of the three groups were all included in both pre-test and post-test evaluations that measured numerous cognitive developmental areas including short term memory, visual processing speeds, auditory processing speeds, retention levels, reasoning skills, and comprehension levels. Randomly selected students from each of the three student groups were also included in pre-test and post-test functional MRI's (fMRI) that measured brain activity during certain skill tests and brain exercise activities. All students and parents were given information regarding the studies and the grant from the National Science Foundation that funded the study and participation in the study was completely voluntary from both the students and the parents (Hill, 2012).

National Science Foundation study. During the 2011-2012 National Science Foundation study, Dr. Oliver Hill and researchers from Virginia State University also studied the effects of cognitive training in the following eleven areas:

- Processing Speed,
- Working Memory,
- Visual Memory,
- Auditory Memory,
- Short-Term Memory,
- Long-Term Memory,
- Visual Processing,
- Word Attack,
- Auditory Analysis,
- Auditory Processing, and
- Matrix Reasoning.

Each of the eleven areas were compared between the one-to-one cognitive training group, the online cognitive training group, and the control group. Pre and post test scores were analyzed and displayed in a graph form such as in Figure 2 below.

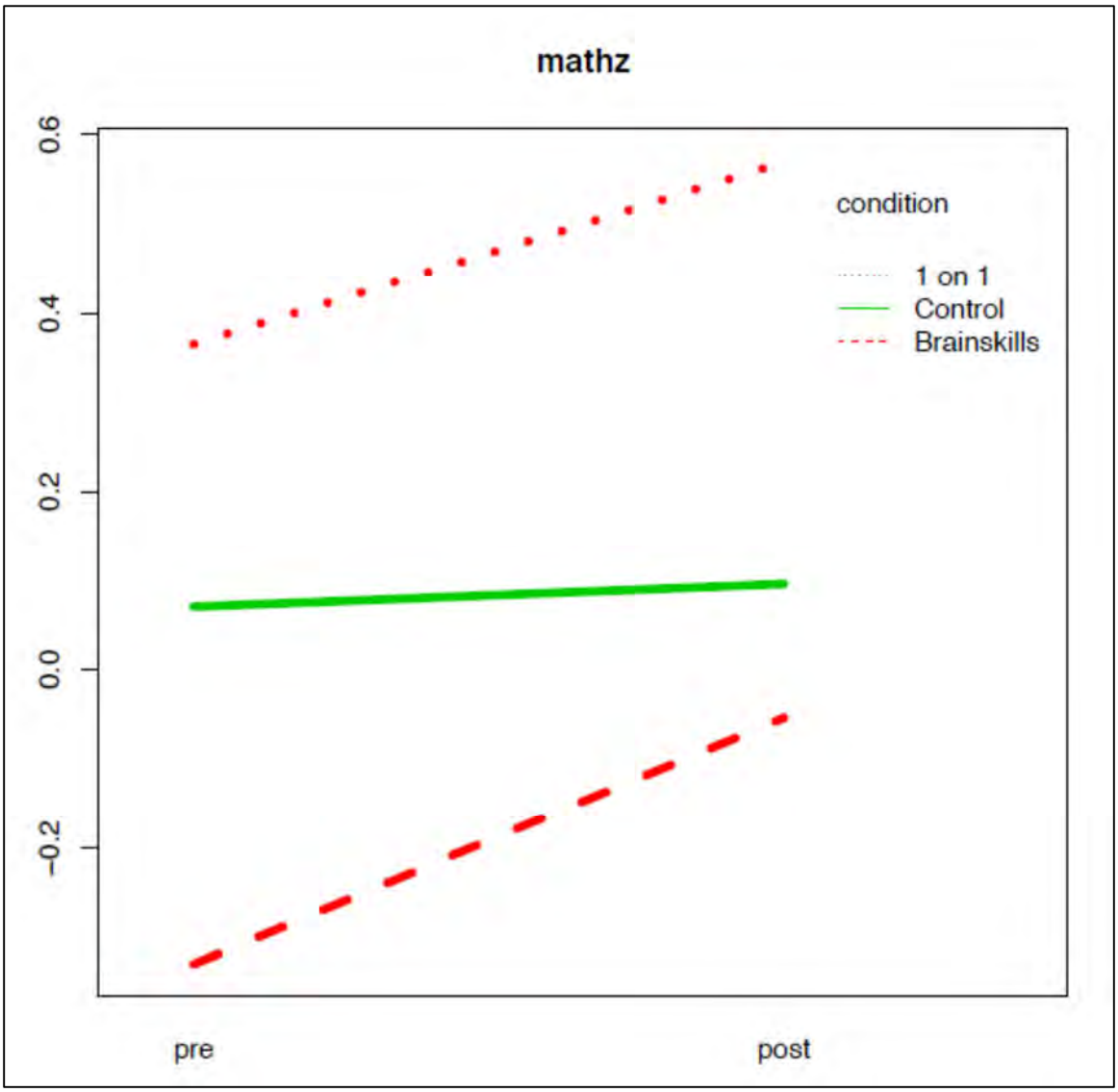

Figure 2. Example of Waskom High School Graph.

The data analysis process from the National Science Foundation (NSF) study is continuing, but some preliminary findings can be shared. Students who completed the

on-line or one-on-one cognitive training showed significantly greater improvement in raw scores from the Texas Assessment of Knowledge and Skills in Mathematics and in the percentage correct out of questions answered. There was no significant difference between the training and control groups on the raw scores or percentage correct from Texas Assessment of Knowledge and Skills in Reading or English/Language Arts. Thus, the research of Hill (2012) got the expected transfer of cognitive skill training to math performance that they initially hypothesized to expect.

Remaining data analysis tasks include assessing cognitive changes captured by f-MRI brain scans of participants to look at changes in the way students process information neutrally after training (Hill, 2012). The researchers from the NSF study are also interested in collecting data from participating students during the 2012-2013 academic year in order to assess the sustainability of the gains from the cognitive training (D. Walker, personal communication, September 2, 2012).

The data that was gathered from the 2011-2012 NSF research project included data from three randomly chosen groups: the control group, an experimental group that received personal one-to-one training from an instructor five times per week for 45 minutes each day, and another experimental group that received online computerized cognitive training from the BrainSkills cognitive training curriculum five times per week for 45 minutes each day. This data was used to measure the academic progress of each group of students from September to May, or one school year.

The Gibson Cognitive Skill Test, which consists of seven subtests, was administered as a pretest and posttest to each student in all three groups. The seven subtests covered the following areas: brain processing speed, measuring working

memory, word attack skills, visual processing, segmenting, auditory analysis, and logic and reasoning. In addition to the Gibson Test, each student was administered the Attitudinal Measurement Test which is measured by a Likert scaled instrument. Randomly selected students in each subgroup were given a functional MRI (fMRI) to measure brain activity for certain portions of brain exercise activities and skill tests. Students' six weeks grades and standardized assessment scores were also analyzed with programs provided to school districts by their regional service centers such as Pearson and Data Management software for Assessment and Curriculum (DMAC).

The participants in the 2011-2012 NSF research project, or population, were all high school students in grades 9-12 at a small, rural high school in Texas. The population of all students was sub-divided into three groups:

1. The control group.
   a. This group took both the pre-test and post-test in cognitive skills.
   b. The control group did not have any change to their daily schedule of classes.
   c. The control group received all "normal" instruction and curriculum offered at the high school.
   d. This group could have an unlimited number of participants.
2. The experimental group that received one-to-one personal cognitive training from an instructor 5 times per week for 45 minutes per day.
   a. This group took both the pre-test and post-test in cognitive skills.
   b. Each student in the 1-1 group had one period assigned to their daily schedule for their 1-1 cognitive training.

c. This group was limited to 70 participants due to the number of personal brain trainers (10) and the number of class periods to utilize them in the schedule (7).

3. The experimental group that received online computerized cognitive training from the BrainSkills cognitive training curriculum 5 times per week for 45 minutes per day.

a. This group took both the pre-test and post-test in cognitive skills.

b. Each student in the BrainSkills group had one period assigned to their daily schedule for their web-based computerized cognitive training exercises and instruction.

c. This group was limited to 140 participants due to the number of seats available in the computer lab (20) and the number of class periods to utilize with an assigned facilitator (7).

All students that had permissions and that did not meet exclusions, were randomly selected into one of the three groups with the above number limitations. The 70 1-1 participants were selected first using the n^{th} method of collecting based upon alphabetical selection of 9^{th} grade, 10^{th} grade, 11^{th} grade, and 12^{th} grade alternating. Next, the 140 participants for the BrainSkills group were selected using the n^{th} method of collecting based upon alphabetical selection of 9^{th} grade, 10^{th} grade, 11^{th} grade, and 12^{th} grade alternating. The remaining population of students was placed in the control group. If, for some reason, a student was removed from the study (withdrew from school, parent revoked permission into study etc…) that student was then replaced by an alternate randomly selected from the same grade level if this occurred before or during the second

six-weeks of school. If this occurred after the second six-weeks of school, that student's data was removed from the study and not replaced.

All the participants in the study were administered a pre-test and post-test of the Gibson Cognitive Skills Test. The Gibson Cognitive Skills Test consisted of seven subtests. Test one was on processing speed. The test of processing speed involved the ability to process information automatically and fluently without having to think through (Mather & Jaffe, 2002). This particular subtest had a total of 50 screens. The student was required to identify which series of numbers in a six digit span was the same or made a pair. A total of two minutes were allotted for this task. If a student scored three items in a row incorrect the task was terminated.

Test two measured the working memory. Working memory is the brain system that provides temporary storage and manipulation of information that is necessary for complex cognitive tasks such as language comprehension, learning, and reasoning (Mather & Jaffe, 2002). This particular subtest involved 26 questions that tested four different types of memory. The four areas of memory tested were short-term memory, long-term memory, auditory memory, and visual memory. Together these four areas make up the working memory. This test did not have a ceiling for terminating the test. However, there was a per question time limit.

Test three measured word attack skills. This test was designed to determine if the student could identify a combination of sounds (Mather & Jaffe, 2002). There were a total of 23 words presented orally to the participants. The participants were then given ten seconds to identify the sound presented in the task. This test would terminate after a participant gave three incorrect answers in a row.

Test four involved visual processing. The participant was required to assemble a puzzle on a computer screen. Each participant was given three minutes to complete this task. The task would terminate early if the participant incorrectly placed a puzzle piece three times in a row.

Test five measured auditory analysis. This subtest was a composite of two subtests. The first part was the segmenting test. The segmenting test consisted of made up words that were stated verbally from the computer. The participant would then determine if all of the sounds were correct from the word presented. There were a total of 13 items for this subtest. The participant had five seconds to respond to each item. The second part of the auditory analysis was the drop test. A pseudo-word was stated and the student was then asked to drop a sound and then select the best of four choices that represented the word that is left after the sound was dropped. There were a total of 13 items for this sub-test. The participant will had five seconds to respond to each item.

Test six was the logic and reasoning part. The participant was presented with a set of patterns with one pattern missing. The participant selected the answer from a set of five choices that best completed the pattern. There were a total of 21 patterns presented to the participant. The participant had 45 seconds for each question and a total of four minutes to complete the test. The test was terminated early if the participant missed three in a row after the first ten questions.

BrainSkills is an online cognitive training program that claims to improve mental skills. BrainSkills uses the science of neuroplasticity to help rewire the brain and create new neural pathways (Blackwell, 2002b). Each participant in the BrainSkills group had a login account. The account allowed the participant to have access to one hour of training

five days a week for approximately 12-15 weeks. The BrainSkills program rotated through a series of executive functioning skills for approximately six minutes.

The one-on-one cognitive training with a brain trainer was provided by a LearningRx cognitive interventionist. The interventionist would present the same types of exercises that were presented in the online BrainSkills program to the participant. The interventionist cycled through executive functioning skills for approximately six minutes. Each participant received one-on-one training for approximately 12-15 weeks.

The attitudinal measurement was administered to each participant. This test was designed to measure different components of attitudes, such as cognitive, affective, and behavioral (McLeod, 2009). The attitudinal scale that was used in this study was modeled after Aiken's 1979 attitudinal scale (Mogari, 2004). The scale has both negative and positive statements that measure the participant's feelings about math and science. The four sets of questions measured the participants' enjoyment of math and science, how the participants valued math and science, their motivation to study math and science, and the participants' beliefs about math and science. The attitudinal measurement consisted of 20 questions. Each participant was responsible for scoring each question with a five for strongly agree, four for agree, three for neutral, two for disagree, and one for strongly disagree. Finally, there was the pre-test and post-test fMRI that was administered to a randomly selected group of participants from the targeted three groups of the study. The fMRI measured the brain activity during certain portions of the brain exercise activities and skill tests.

Prior to the study, the National Science Foundation researchers obtained permission from the Waskom ISD Superintendent, Mr. Jimmy Cox. Also, permission

was obtained from the Waskom High School Principal, Mr. Stuart Musick and the Waskom High School staff members. After permission was obtained from the three entities, the researcher then invited all students, parents, and school faculty and staff to an informational meeting detailing the nature of the research and a complete description of the groups that were to be used in the study. The faculty and staff at the school were provided with professional development training on the study. The campus instructional specialist teams were also trained on how to administer and collect the pre-test and post-test material. Permission slips were given to students, mailed home, and passed out at the informational meetings. The returned signed permission slips indicated that the participation is voluntarily and that the participants had the right to withdraw from the study at any time. There was a two week time frame for collecting permission slips. Once the permission slip process was completed, the researchers randomly select students for each group.

The first phase of data was collected at the beginning of the school year in September from all the participants. Each participant will took the pretest of the Gibson Cognitive Skills Test and the Attitudinal Measurement that was pre-coded with each student's age, grade ethnicity, and random identification number. The pretest was administered by the campus instructional specialist teams. Once the pre-test and the Attitudinal Measurement were complete, they were then collected and analyzed. The pre-test fMRI was conducted on the random group of participants from each of the three preselected groups.

The second phase involved the control group which continued with the traditional school schedule. The first experimental group participated in a one-on-one cognitive

training session with a trained LearningRx cognitive interventionist for 45 minutes per day. The second experimental group would participate in a 45 minute per day computerized cognitive training program called BrainSkills. The BrainSkills program uses the science of neuroplasticity to help rewire the brain, create new neural pathways were there may have been none or few (Blackwell, 2002b).

Phase three involved the collection of six week grades for each of the six yearly grading periods and the two semester grades for all participants. Those grades were then collected and analyzed through the Public Education Information Management System (PEIMS) program and DMAC. Grades were compared for each student relative to previous years to determine whether or not there was a significant improvement in achievement.

Phase four involved the administration and analyzing of the post-test of the Gibson Cognitive Skills Test and the attitudinal measurement for all groups. Then the post fMRI was completed for the randomly selected participants. That data was analyzed to determine whether or not there was a significant improvement from the beginning of the study to the end of the year. The pre-test and post-test of the Gibson Cognitive Skills Test were scored and analyzed through the Gibson Test of Cognitive Skills Assessment. This software helped to identify four sections of data. Section one provided a list of test results by age equivalent and percentile. Section two provided the test results in graph form. Section three provided the performance rating scale results which showed the comparison and correlation between performance activities and underlying cognitive skills. Section four provided a comprehensive explanation of the cognitive skills tested.

The attitudinal measurement was scored using a Likert Scale technique. The subjects were asked to express agreement or disagreement on a five point scale. Each degree of agreement or disagreement was given a numerical value from one to five. A numerical sum value was calculated from all the responses. All of the six week grades and semester grades were calculated in PEIMS reports DMAC data reports. The standardized test scores were calculated in the Pearson Assessment Component. Through the analysis process the researchers were able to determine the impact of cognitive training on the participants in the study.

The preliminary data from the previously mentioned studies of students from Waskom ISD showed significantly improved post-test results in those students that were included in both the BrainSkills computerized training and those students involved in the one-on-one cognitive training exercises (Hill, 2012). The NSF data was able to graph and illustrate the pre and post-test differences between the three groups showing marked improvements in both the BrainSkills and Cognitive training students.

Summary

While the implementation of cognitive training in the classroom has just recently and slowly been introduced into the classroom, there are numerous studies and research that can be found dating back over the past several decades (Roberge & Craven, 1982). What has been more prevalent with the development of the innovative, technological advances that have been made is that there is certainly no lack for software or programs that are available to purchase. Also, there are numerous companies and programs that market their product as the most effective tool to ensure student success and improvement.

Chapter III

Methodology

This chapter was organized by stating the purpose of the study, the research questions used to guide this study, and the research design of the study. Next, the participants of the study, the setting, the instrumentation, and the data collection procedures were listed. Next, how the data was treated and the trustworthiness of the study was mentioned. Finally, the chapter concluded with the epoche and the summary.

Whether you are a classroom teacher or a coach, both look for ways to increase student, or student-athlete, success. The same is true as an administrator. No matter what the role or what the title may be, educators seek the most effective strategy to increase learning. There are numerous companies or organizations that claim that their software or their packages are the way to go (Bryan, 2014). The concern for the public school administrator with little or no money to spend in additional areas is how they can get the most bang for their buck to help their students succeed (Rode et al., 2014).

In a time where school districts have received a decreased revenue and funding from the state, many districts have decreased staffing which leads to larger classes (Stutz, 2013). The question then becomes how we can effectively and efficiently utilize our programs and our personnel to maximize student success. The cognitive training industry is a multi-million dollar industry (Aamodt & Wang, 2007) that is focused on their profits. That conflicts with the goal of schools that are focused on cutting costs while still maintaining student success (Stutz, 2013).

Purpose of the Study

The purpose of this qualitative case study was to examine practical, effective applications of implementing a cognitive training curriculum into a school with the intent of helping all students be successful. By using cognitive training programs in the classroom, the intent of helping high school students increase student achievement may be realized by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

Research Questions

This qualitative case study examines a rural school's experience to determine if various forms of cognitive training in an academic setting will have a greater increase in overall academic achievement. Using an interview protocol, documentation, and observations, the following research questions will be addressed:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
2. What components of online computerized cognitive training are perceived as practical and effective?
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?

Research Design

The research design in a qualitative study includes committing extensive time in the field, engaging in a complex, time-consuming process of data analysis, writing narrative passages, and using a form of social and human science research (Creswell,

2013). Using a qualitative single instrumental case study, the researcher focused on an issue of learning difficulties and how to improve student achievement in the classrooms and school. Also, documentation, observations, and interviews will be used to gather information and data in regards to their attitudes toward the cognitive training activities.

Participants and Setting

The researcher in this study was considered a participant as an observer (Creswell, 2013). The researcher participated in the activity at the site, but was not fully or directly engaged in all of the learning activities that took place in the classroom. This role helped the researcher gain insider views from the participants, as well as subjective data (Creswell, 2013).

This study was conducted using a qualitative design methodology and holistic analysis to gather data on the use of brain-training with all high school students in grades 9-12 at a small 3-A rural school district located in East Texas. The participants in the case study consisted of five teachers from Waskom High School, seven students that were a part of the 2011-2012 cognitive training groups, four brain trainers from LearningRx that participated in the cognitive training, one BrainSkills facilitator, and three researchers included in the National Science Foundation research project. The demographics of the case study consisted of interviewing the following:

- Students – A total of seven students, ages 18-19, were interviewed. Four students were female and three students were male. Of the four female students, three were Caucasian and one was African-American. Of the three male students, all three were Caucasian.

- Teachers – A total of five teachers were interviewed. Three teachers were female and two were male. All five teachers were Caucasian.
- Trainers – A total of three brain trainers were interviewed. Two trainers were female and one was male. The male trainer was Caucasian. Of the two female trainers, one was Caucasian and one was African-American.
- Facilitator – One Caucasian, female facilitator of the online BrainSkills training was interviewed.
- Researchers – Three researchers were interviewed. All three researchers were Caucasian females.
- This qualitative case study included interviews, observations, and the collection of data from documentation.

Students that participated in the National Science Foundation research project did so voluntarily and with parental consent to participate. In addition, students were randomly selected and placed into one of the three groups including the one-to-one cognitive training group, the computer-based BrainSkills cognitive training group, or the control group. The random assignment of participants to the three groups assured to some degree that the three groups could be equally represented from the student population.

For interviewing purposes, the students were selected using the following processes:

- Students that were in either the one-to-one cognitive training group or the computer-based BrainSkills group,

- Students that were included in the 2011-2012 National Science Foundation research project,
- Students that were still enrolled at Waskom High School, and
- Students were then selected based upon availability from the current Principal of Waskom High School based upon class schedule.

Data Collection

The data gathered for this qualitative single instrument case study included interviews from teachers and staff members from Waskom High School, interviews with the one-to-one brain trainers, interviews from the BrainSkills facilitators, and interviews with participants from the study. Other forms of data collection included documentation used during the school year of the research. Also, observations were included from both direct observations and participant observations.

The process for collecting data included five teachers interviewed, seven students interviewed, four brain trainers interviewed, one BrainSkills facilitator interviewed, and three researchers interviewed. The interview questions that were used were based off of the following research questions that guided the case study:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
2. What components of online computerized cognitive training are perceived as practical and effective?
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?

Data Collection Procedures

In a qualitative case study, the data collection is usually extensive and includes multiple sources of information (Creswell, 2013). Yin (2009) recommended six types of information to collect:

1. Documents,
2. Archival Records,
3. Interviews,
4. Direct Observations,
5. Participant Observation, and
6. Physical Artifacts.

This qualitative case study utilized four of the six types of information for data collection described by Yin (2009) including interviews from teachers and staff members from Waskom High School, interviews with the one-to-one brain trainers, interviews from the BrainSkills facilitators, and interviews with participants from the study. Other forms of data collection included documentation used during the school year of the research. Also, observations were included from both direct observations and participant observations.

Treatment of the Data

The type of analysis for this case study was a holistic analysis of the entire single instrumental case (Yin, 2009). The researcher tried to develop a complex picture of the problem or issue to be considered in the study (Creswell, 2013).

This study utilized four types of information for data collection including interviews from teachers and staff members from Waskom High School, interviews with the one-to-one brain trainers, interviews from the BrainSkills facilitators, and interviews with participants from the study. Other forms of data collection included documentation used during the school year of the research. Also, observations were included from both direct observations and participant observations.

Provisions of Trustworthiness

Provisions were made to ensure the integrity of the study and the validity of the data. These provisions included random sampling, random assignment, and random selection of students to be included in all three of the study groups. Trustworthiness, or validity, helps to ensure both the ethical considerations and the political considerations of the study (Creswell, 2013).

Epoche

The researcher in this study was considered a participant as an observer (Creswell, 2013). The researcher participated in the activity at the site, but was not fully or directly engaged in all of the learning activities that took place in the classroom. This role helped the researcher gain insider views from the participants, as well as subjective data (p. 167).

As the High School Principal where the study and research was being conducted, there was an obvious motivation to desire a positive outcome on student learning and student achievement. The biggest hurdle was to look at each of the three study groups as an impartial, participant observer and examine the data for what it was and for what it proved. As the Principal, the researcher also had a desire to help those students that were

marginal or struggling students and give them the best possible scenario for success. While there was a desire and wish to place those students in a particular experimental group, the validity of the study and random selection process had to be maintained at all times.

Summary

While the implementation of cognitive training in the classroom has just recently and slowly been introduced into the classroom, there are numerous studies and research that can be found dating back over the past several decades. What has been more prevalent with the development of the innovative, technological advances that have been made, is that there is certainly no lack for software or programs out on the market that are available to purchase or companies that market their product as the most effective tool to ensure student success and improvement.

Chapter IV

Analysis of the Data

Whether you are a classroom teacher or a coach, both look for ways to increase student, or student-athlete, success. The same is true as an administrator. No matter what the role or what the title may be, educators seek the most effective strategy to increase learning. There are numerous companies or organizations that claim that their software or their packages are the way to go (Bryan, 2014). The concern for the public school administrator with little or no money to spend in additional areas is how they can be more cost effective to help their students succeed (Rode et al., 2014).

In a time where school districts have decreased revenue and funding from the state, many districts have decreased staffing which leads to larger class sizes (Stutz, 2013). The question then becomes how we can effectively and efficiently utilize our programs and our personnel to maximize student success. The cognitive training industry is a multi-million dollar industry (Aamodt & Wang, 2007) that is focused on their profits. That conflicts with the goal of schools that are focused on cutting costs while still maintaining student success (Stutz, 2013).

This chapter was organized to present the findings of the 2011-2012 National Science Foundation research project conducted at Waskom High School. Secondly, this chapter presented the findings from the interviews with the teachers and the students from Waskom High School. Also, this chapter presented the findings from the interviews with the individual brain trainers, the BrainSkills facilitators, and the researchers involved with the research project.

Presenting the Findings

The following sections present the findings and information from the National Science Foundation (NSF) research project, interviews with the teachers, interviews with the students, and interviews with the researchers involved at Waskom High School. The three research questions were used to guide the interview protocol and create the interview question document. The interview protocol document is listed as Appendix I. Those research questions were:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
2. What components of online computerized cognitive training are perceived as practical and effective?
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?

The guided protocol included the following questions included in Appendix I:

1. Did the students that participated in the daily one-on-one personal cognitive training for 45 minutes per day see significant improvement in their academic achievement compared to students that did not receive the one-on-one personal cognitive training?
2. Did the students that participated in the daily online computerized cognitive training from the BrainSkills cognitive training curriculum see significant improvement in their academic achievement compared to students that did not receive the daily BrainSkills cognitive training?

3. What suggestions do you have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance?
4. As a student, would you participate in a cognitive training class again if offered?

There were five teachers interviewed, seven students interviewed, four brain trainers interviewed, one BrainSkills facilitator interviewed, and three researchers interviewed. For this case study, the students were divided into the following categories as illustrated in Table 1 below.

Table 1

Student Table

Student	***Study Group***	***Gender***	***Ethnicity***
Student A	One-to One Training	Female	Caucasian
Student B	One-to One Training	Female	African-American
Student C	One-to One Training	Male	Caucasian
Student D	BrainSkills Training	Female	Caucasian
Student E	BrainSkills Training	Male	Caucasian
Student F	BrainSkills Training	Female	Caucasian
Student G	BrainSkills Training	Male	Caucasian

National Science Foundation Research Project Findings

Dr. Oliver Hill, Dr. Zewelanji Serpell, and Dr. Omar Faison (2014) recently submitted their preliminary findings from the 2011-2012 National Science Foundation (NSF) Research Project performed at Waskom High School. The research project compared the effectiveness of two separate cognitive trainings programs in the classroom setting. First, a one-to-one cognitive training was performed by individual brain trainers

trained and employed by LearningRx. Each student had one 45 minute period in their daily schedule with a personal brain trainer. Secondly, a computer-based cognitive training program entitled BrainSkills. Each student had one 45 minute class period built into their daily schedule for the computerized BrainSkills cognitive training. Each of these two groups was treated as experimental groups in the research project. A third group was set up as a control group with no cognitive training being performed.

The student population in the research project included 57 students in grades 9-12. There were 24 male students and 33 female students in the experimental groups. The ethnicity sub-populations of the experimental groups included 6 African-Americans, 16 Hispanics, 33 Caucasians, 1 student that was multiple ethnicities, and 1 Native American. Cognitive skills were assessed in 12 areas from both a pre-test at the beginning of the semester and a post-test at the end of the 15 week training.

The preliminary results from the study indicated significant gains in cognitive skills for those students placed in the one-to-one LearningRx program, as compared to the control group, in 9 of the 12 cognitive areas. Those 9 areas included working memory, visual memory, short-term memory, long-term memory, word attack, auditory segmenting analysis, auditory drop analysis, auditory processing, and matrix reasoning. Results found that the one-to-one LearningRx students had the most significant gains in the areas of word attack (decoding) and auditory analysis (phonemic parsing). These two skills are particularly important areas used in reading. The preliminary results also indicated significant gains in 4 of the 12 cognitive areas for those students placed in the computerized BrainSkills training group, as compared to the control group. Those areas

of improvement included working memory, visual memory, word attack, and auditory segmenting analysis. All of these areas of improvement are illustrated in Table 2 below.

Table 2

Summary of Findings

TABLE 2	LearningRX		Brainskills		Control				
	Mean	SD	Mean	SD	Mean	SD	F(2,54)	Sig.	η2
Processing Speed	35.89	2.885	34.58	3.517	32.84	9.069	1.583	.215	.052
Working Memory	*15.74	2.557	*14.58	1.774	12.95	3.659	5.739	.006	.148
Visual Memory	*10.21	1.437	*9.53	1.541	8.21	2.394	5.479	.007	.157
Auditory Memory	10.58	2.479	9.21	2.016	9.05	2.877	2.009	.144	.048
Short-Term Memory	*10.79	1.686	10.00	1.202	9.42	2.168	3.257	.046	.095
Long-Term Memory	*10.00	1.944	8.74	2.353	7.84	3.005	2.914	.063	.084
Visual Processing	35.42	7.430	31.37	9.840	31.05	12.920	.005	.995	.000
Word Attack	*18.84	2.500	*18.63	1.499	17.00	3.448	6.363	.003	.154
Aud. Anal.-Segmenting	*10.21	2.551	*9.79	2.016	7.84	3.500	5.243	.008	.143
Aud. Analysis - Drop	*11.05	2.094	8.89	2.558	8.84	2.630	5.119	.009	.112
Auditory Processing	*21.26	4.267	18.68	4.056	16.68	5.687	4.830	.012	.105
Matrix Reasoning	*10.00	2.380	9.58	3.061	8.53	3.389	2.140	.128	.066
		* Indicates significant difference from control group							

Teacher Interviews

Teachers who were on staff at Waskom High School during the National Science Foundation research project during the 2011-2012 school year were interviewed to get their perspectives on how the cognitive training affected their students. All of the teachers interviewed are still teaching at Waskom High School and several have had these students for multiple classes over the past four years. A total of five teachers were interviewed. Three teachers were female and two were male. All five teachers were Caucasian. The three female teachers included a Science teacher, an English/Reading teacher, and a Family Consumer Sciences teacher from the Career and Technical Education (CTE) field. The two male teachers that were interviewed included a Math

teacher and a Social Studies teacher. All four of the core subject areas plus a Career and Technical Education field were covered by those interviewed.

Teacher A. The first teacher interviewed had taught three of the seven students that were selected for this case study. Those students included Students A, D, and E from Table 1 above. Concerning the first two research questions, with the first student, Student A from the one-to-one training group, she recalled the student was able to begin focusing more in her class during and following the cognitive training. She also noted that there was noticeable improvement in her classroom performance due to the student's improved focus. With the second student, Student D from the BrainSkills group, the teacher also noted improvement in the areas of focus and concentration. The teacher stated that this student also matured in her classroom during the cognitive training and seemed to have more purpose to the work and to the academic performance. Student E was also in the BrainSkills training group. The teacher discussed how she did not notice any apparent changes in the third student during or following the cognitive training. However, this student was identified as being weak in the area of logic. She recalled this student having difficulties in separating between hypothetical reality and fiction in her class. Because of the initial diagnosis from the cognitive pre-test, it did cause her to rethink the way that she approached some of the discussions in her class and with this student in particular.

As far as research question number three and the practical applications of cognitive training and how it may be implemented into the school setting or curriculum, Teacher A had the following thoughts:

- To keep it practical, the school should consider implementing the BrainSkills computerized curriculum over the one-to-one training program. This way, the facilitator could be used in a computer lab setting to allow for up to 20 students to be engaged at a time with one facilitator during each class period.
- The training helped the students to think about their thinking more and slow down to not rush.
- For the 8th graders that were coming up to the high school level, the cognitive pre-test could be used to help implement an accelerated instruction plan for those students that needed remediation.
- She also noted that it could be used for a summer school remediation program.
- She also discussed the possibility of using the cognitive training as an activity for the gifted and talented students.
- Cognitive training could be used to train the teachers as staff development and teachers could then use some of the one-to-one activities as bell ringers or warm-ups, but with the whole class instead of one-to-one.

Teacher B. The second teacher that was interviewed had taught six of the seven students that were selected in the case study. These students included Students A, B, D, E, F, and G. Concerning the first two research questions, the teacher reported that Student A not only matured in his class, but was able to focus and pay attention much more following the one-to-one cognitive training. Because of this, the teacher stated that the student had fewer discipline problems in his class since her behavior was much better than before. The teacher also noted that Student B was also more mature and focused after the cognitive training from the one-to-one trainer. From the BrainSkills students,

the teacher stated that Student D did not show many differences from beginning to end. The teacher noted that Student D had a lot of natural ability and intelligence before the training and continued to do well after the training. Student E was reported to be more pragmatic and realistic following the BrainSkills training. The teacher noted that this student did a better job of taking care of his business by turning in assignments and staying more organized with his thoughts. The teacher recalled that he made A's before the training, but that his work was even better after the cognitive training. Next, the teacher discussed how Students F and G were both immature as freshmen, but did much better in his class as sophomores. There was no indication of whether or not the maturity was thought to have come from age or from the cognitive training.

Research question number three brought the following thoughts:

- That the computer-based BrainSkills program could be used for both Special Education students as well as higher level or Gifted and Talented (GT) students.
- The computerized program could be used to help remediation students get caught up while the teacher is able to work with other students during guided practice.
- That students could be used as individual tutors to help other students with their learning and thinking skills.
- That teachers and staff members could be trained and then utilized as trainers during their schedule each day or to utilize a study hall period where teachers were able to rotate through a one-to-one training with students.

Teacher C. The third teacher interviewed had five of the seven case study students in her class including Students A, C, D, F, and G. Concerning the first two research questions, Student A was reported to have matured greatly from the beginning of

her freshman year before the cognitive training. The teacher noted a change in the student that was now more organized and gets her work done on time. Student C would feel that he was under a lot of pressure before the one-to-one cognitive training routines. Following the training, the student was reported to be able to handle pressure better without getting frustrated and losing focus. Student D was able to organize and focus better after the training. Student F was also reported to be more organized and had become an over-achiever. She had slowed down and focused more on getting it right the first time when it came to her work which was much more thorough. Student G was reported by the teacher to have been able to catch on quicker and had many more "I got it" moments in class. The teacher also compared both experimental groups to the control group and stated that the control group, as a whole, had much more trouble staying on task.

When asked how a cognitive training or cognitive training program could be implemented in research question number three, the teacher had the following ideas:

- The idea was presented that students could first be pre-tested to identify areas of weaknesses, then the students could be grouped together to work on those areas.
- Could also be used for the dyslexia students to work on reading modifications with the teacher.
- That staff development should include training teachers in the LearningRx strategies of one-to-one training so that the practices of teaching and learning strategies could be embedded into the curriculum and lesson planning.

Teacher D. The fourth teacher had two of the case study students in her classes previously, which included Students B and G. Concerning the first two research

questions, Student B was described as very task-oriented and very thorough both before and after going through the cognitive training program. She was also described as someone that would often get bogged down and repeatedly ask for help. However, after the cognitive training, was later remember to do much better of being a problem solver and trying to come up with a solution before coming to the teacher for help. Student G was noted as having some obsessive-compulsive tendencies. He became more organized after cognitive training. The teacher also stated that her two students would challenge information and think at higher levels of thinking. They were also considered to be quiet students, but still considered as leaders in her class.

Teacher D brainstormed the following information regarding how a cognitive training curriculum could be implemented:

- Stated that all teachers could be trained and could incorporate the strategies into their teaching and lessons.
- To use the vocabulary skills as remedial tools to help those students that struggle.
- The cognitive training could help to differentiate some of the teaching strategies and activities throughout the year by including a variety of ways to present information.
- That different cognitive skills could be focused on throughout each week, six-weeks, and the semester.

Teacher E. The fifth teacher interviewed had taught four of the seven case study students including Students A, B, C, and G. Concerning the first two research questions, all four of these students were taught as either juniors or seniors, or both. While this teacher did not have prior knowledge of how the students were during their freshman

year when they participated in the cognitive training, he was able to describe them as students following training. The teacher described Student A as a student that did well in his on-level class during the student's junior year. The teacher described her as a normal student that did well in his class, but did not excel. Students B and C were both students that were in upper level classes that were described as top students that excelled in his class. As juniors, both of these students were in an upper level high school class. As seniors, these students were in college level, dual-credit courses and did very well. Student G was reported to have been an average student that was a little bit below grade level as a junior, but did well in his class.

When discussing how a cognitive training curriculum could be implemented, the teacher had the following comments and ideas:

- Teachers could be trained in cognitive training exercises and use these as warm-up activities at the beginning of each class with all students.
- Other than staff development, this could be done at little or no cost to the district.
- The key would be to invest in training teachers through staff development. This would also help to create a sense of buy-in or agreement within the staff.
- Also stated that before an investment into the training took place, that there should be research based data to prove significant improvement that comes from this type of curriculum or program.
- Could use the pre-test cognitive assessment to determine how students could be grouped for training purposes.
- Could also help remediate sub-groups and populations of students that need to narrow the achievement gaps in learning.

Themes from teacher interviews. The following themes emerged from interviewing the teachers based upon the three research questions:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
    - The teachers observed that students were able to focus and concentrate more in class.
    - The teachers observed that students were perceived to be more mature and had fewer discipline problems.
    - The teachers observed that students became more organized and were able to keep up with assignments better.
    - The teachers observed that the students were able to perform better both on class assignments and on homework assignments.
2. What components of online computerized cognitive training are perceived as practical and effective?
    - No themes emerged from the teacher interviews related to this research question.
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?
    - Teachers recommended that the cognitive training should be included into a school curriculum.
    - Teachers suggested that cognitive training could be included for both remediation and credit recovery, such as summer school.

- Teachers suggested that cognitive training could also be used for enrichment activities including with Gifted and Talented (GT) students.
- The teachers stated that students could be assessed with early on pre-testing to identify areas of learning weakness or deficiencies.
- The teachers recommended that students be grouped by identified areas of learning difficulty for remediation and tutoring.
- Most importantly, the teachers stressed the need for ongoing, intensive staff development to train the teachers in cognitive teaching strategies and activities.

Student Interviews

A total of seven students, ages 18-19, were interviewed. Four students were female and three students were male. Of the four female students, three were Caucasian and one was African-American. Of the three male students, all three were Caucasian. Since each of the students were only involved in one of the two experimental groups, the research question that did not pertain to them was omitted from the interview. Therefore, each student was either asked research question number one or number two depending on whether they were in the one-to-one training group or the computer-based BrainSkills group. All students were asked research question number three regarding implementation of a cognitive training curriculum.

Student A. When asked if the personal one-to-one cognitive training program produced significant improvement in their student achievement, the student stated that the training helped her remember things better. She recalled memorizing and reciting the list of Presidents and how the pictures helped her to connect items and remember. She

recalled retaining information better since they did the training on a daily basis. She stated that the students were taught memorizing techniques. She also stated that the transitions from one activity segment to the next were very fast and at first it was hard to concentrate, but that they were taught how to focus and concentrate on the task at hand. She also stated that the multi-tasking exercises trained her and prepared her for juggling her different activities between classes and band.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that teachers could use the cognitive training strategies at the beginning of class as a warm-up activity. She also had the idea that students could play a game-association with the different subject matters. She discussed the idea that teachers could get trained as brain trainers and that the teachers could even train the class.

When asked if the student would participate in a cognitive training class again if offered, the student replied that she would. She included that she liked the class most days, but that frustration levels early on in the semester caused her stress. She did, however, state that the program helped her to learn how to deal with stress and not let it get to her. She also felt that students should learn at different speeds and in different ways.

Student B. When asked if the personal one-to-one cognitive training program produced significant improvement in their student achievement, the student stated that it helped her to focus and concentrate on her assignments. She recalled an activity that included counting with a metronome and being able to multi-task different activities. The student also stated that the memorization techniques helped her Algebra grade to improve

from the training that they received. She also recalled the word association exercises that helped her to associate different information and made it easier to recall.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that the tips and tricks that they were taught would be beneficial to all students. She also stated that the word association strategies should be taught and used in a whole-class setting.

When asked if the student would participate in a cognitive training class again if offered, the student replied that she liked the training and would take it again. She felt that it prepared her to be a better student.

Student C. When asked if the personal one-to-one cognitive training program produced significant improvement in their student achievement, the student stated that the tricks that the trainer taught him helped to group items of information which helped his study habits to recall information. He also recalled being taught to focus on key points rather than the details. He stated that this helped him study a little bit, but did not seem to make a big difference in his performance.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that the class could be offered as an elective for any student that wanted to take it. He also stated that the one-to-one setting would be the best option to help students learn. This type of training could help students with reaction times and with their mental sharpness.

When asked if the student would participate in a cognitive training class again if offered, the student replied that he would. The student stated that the trainer would keep pushing him and then kept speeding up. He remembered getting frustrated to the point

that he would just stop and say, “I’m done!” The student said that there were days that “I hated her” and wanted to quit, but that the next day he would tell her “Thank you!” for pushing him and making him keep going.

Student D. When asked if the computer-based BrainSkills cognitive training program produced significant improvement in their student achievement, the student stated that the program made her more confident and more organized. She stated that it helped her to concentrate more and remember to look at the small details when doing her assignments.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that it would be good to train the teachers how to be trainers like the one-to-one brain trainers. She also stated that the teachers could use the exercises for test-taking strategies and teach students how to concentrate more and be better at taking tests.

When asked if the student would participate in a cognitive training class again if offered, the student replied that she would and that she enjoyed the class. She stated that at the beginning of the semester she didn’t take it very seriously, but as they went along she began to try harder and got more competitive with it to try and beat her times and better her scores.

Student E. When asked if the computer-based BrainSkills cognitive training program produced significant improvement in their student achievement, the student stated that after going through the training program that his grades improved. He also stated that the process of going through the program and going to the class every day was a good idea. It helped me to stay focused and try harder. He recalled some of the

matching exercises as well as remembering how the program would start off with single-step problems and then got harder as it progressed to multi-step problems. He mentioned that his post-test functional MRI was much better than his pre-test before going through the training. He also bragged about comparing their fMRI's and seeing which student had the biggest brain.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that the school should have a class designated for every student to go through the training just like one of the core classes. He stated that the school could offer it as a local elective, but require that the course is taken before graduation. He suggested that it could be offered as a school club or organization for those that wanted to participate more in the training and even work on it at home if the student had internet access.

When asked if the student would participate in a cognitive training class again if offered, the student replied that he wanted to take the class. He stated that he was curious to whether or not the class would make him smarter. He wished that the class was still offered and that he would do the training again if it was available.

Student F. When asked if the computer-based BrainSkills cognitive training program produced significant improvement in their student achievement, the student stated that it helped her memory and helped her recall things that she had studied. She specifically stated that it helped her in Math to be able to figure questions out faster and easier. She stated that she could tell a difference in how it helped her brain and thinking to develop. She also said that the lessons and the activities got harder and harder as you went along.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that she would also suggest that it be a course requirement to graduate. She mentioned that the teachers could be trained in how to take some of the games from the BrainSkills program and make it fit with their class.

When asked if the student would participate in a cognitive training class again if offered, the student replied "If I had the chance, I'd want to develop my brain. Who wouldn't?" She said that she enjoyed the class and would love to take it again. She was also curious to see if she could get even smarter by taking the class over.

Student G. When asked if the computer-based BrainSkills cognitive training program produced significant improvement in their student achievement, the student stated that the program helped him to understand things better. He stated that before the training, he had a hard time understanding and remembering things in class. However, he felt that after the semester of cognitive training that he could remember details from class better and that would also help him when he did his homework.

When asked how a cognitive training program could be best implemented or added into the school curriculum, the student stated that it would help the students remember information if they are able to see it first and then process it. He stated that allowing students to take the BrainSkills class would help students remember the pictures that they saw and be able to remember them longer.

When asked if the student would participate in a cognitive training class again if offered, the student replied "Yeah. I'd take it again."

Themes from student interviews. The following themes emerged from interviewing the students based upon the three research questions:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
    - The students stated that they were able to remember and recall information quicker and better after cognitive training.
    - The students stated that they were able to focus and concentrate more in class.
    - The students stated that they felt more confident in answering questions during class discussions.
    - The students stated that they felt more organized and were able to keep up with assignments better.
    - The students stated that they were able to perform better both on class assignments and on homework assignments.
2. What components of online computerized cognitive training are perceived as practical and effective?
    - The students stated that they were able to remember and recall information quicker and better after cognitive training.
    - The students stated that they were able to focus and concentrate more in class.
    - The students stated that they felt more confident in answering questions during class discussions.

- The students stated that they felt more organized and were able to keep up with assignments better.
- The students stated that they were able to perform better both on class assignments and on homework assignments.

3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?
    - The students suggested that the cognitive training could be done as an exercise at the beginning of the class period as a class.
    - The students stated that the teachers could teach the "tricks" to all of their students to help them on assignments, when studying for tests, and to recall information when taking tests.
    - Some students suggested that the class be offered in the curriculum as an elective course, so that only students that wanted to participate were enrolled in the class. Other students suggested that the class should be required of all students because it could help everyone become a better learner.
    - Most importantly, the students suggested that teachers get trained in cognitive training exercises and strategies to become a trainer.
4. As a student, would you participate in a cognitive training class again if offered?
    - Each student interviewed stated that they would take the cognitive training class again, if offered. This included students from both the one-to-one group and the computer-based cognitive training group.

Trainer Interviews

A total of three brain trainers were interviewed. Two trainers were female and one was male. The male trainer was Caucasian. Of the two female trainers, one was Caucasian and one was African-American. It is also important to note that the personal brain trainers did not have access to student records to examine whether or not students had better grades, did better on tests, or performed better in class due to the cognitive training. Most of the information that they received came from the training itself, along with personal interaction with the students. Another important fact is that while the personal brain trainers also have training in the computerized BrainSkills program, they were not directly involved with the computerized BrainSkills students during the 2011-2012 National Science Foundation research project.

Trainer 1. When asked if the students that participated in the daily one-to-one personal cognitive training saw significant improvement in their academic achievement, the trainer stated that students said that they were able to recall information better. She also stated that they spent less time on homework due to the fact that they remembered better and thought faster. She quoted one student to say that "It feels like I'm cheating. I just get it better." The trainer went on to state that students seemed to grasp Math better due to the attention computing, pushing retrieval, memory digits, and grouping exercises. She went on to elaborate that the processing and memory hold exercises were two of the hardest activities for the students. The trainer stated that students expressed to her the ability to keep up with their teacher better from the training. The trainer also saw improvement in the two and three step processes involved in the training exercises. She stated that the students' reading comprehension had improved and the students would

only have to read a passage one time in order to comprehend it better. She also noted that her students' anxiety had decreased over the course of the semester of training. Along with that, she noted that her students' behaviors had changed and improved throughout the training.

When asked if the students that participated in the daily computerized BrainSkills program saw significant improvement in their academic achievement, the trainer stated that the students would definitely have a leg up on the control group who received no training. She stated that the BrainSkills program helps to keep your mind sharp. She noticed that students would sit up straighter and stay more focused when they were trying their best on the computer skill. She said that the BrainSkills and one-to-one training have similar activities and concepts. She stated that one of the harder exercises includes putting puzzles together while the puzzle starts to move and rotate. It makes the training competitive, but in a good, positive way for the students.

When asked what suggestions they would have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance, the trainer listed the following suggestions:

- The best case scenario would be a one-to-one setting for the students, but that would probably not be cost effective for the district.
- That BrainSkills would probably be the best and most logical approach.
- To have all of the students tested and then focus on improving certain concepts for each student or group. To have students pulled out in groups based on their areas of weakness or need. This way, you could treat the underlying cause of the learning difficulty.

- That teachers could be trained, could learn, and even excel and see benefits from the training themselves as learners. She compared her own current nursing program that she attends and how her training has benefitted her by helping her to assess patients faster and more accurately. She also highlighted a noticeable difference in her decreased stress levels compared to her peers in the program.

Trainer 2. When asked if the students that participated in the daily one-to-one personal cognitive training saw significant improvement in their academic achievement, the trainer recalled one student that was diagnosed with ADHD and how they had become more focused, more calm, and more confident. The biggest area that she highlighted with most students was the ability to focus and concentrate better after going through the one-to-one training. She also noted that students get less and less frustrated as they continue in the program. She went on to describe how students become better at attacking the skills needed for each exercise.

When asked if the students that participated in the daily computerized BrainSkills program saw significant improvement in their academic achievement, the trainer stated that it requires students to work by themselves. For some that would be beneficial, but for some that would not be an advantage over working directly with another person or other students. She stated that BrainSkills is more memory based and uses repetition while in the one-to-one program the trainer is able to change it up and keep it from being so repetitive.

When asked what suggestions they would have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance, the trainer listed the following suggestions:

- That the computer-based BrainSkills program is not as expensive.
- That teachers would have to demonstrate and convey to their students the practical applications and how these skills would help.
- That the class could be a mandatory elective for the students to take.
- There would be a definite benefit to put trainers into the school system.
- A key would be to use the pre-test assessment to help target students that needed help.
- She suggested to train students to become trainers and utilize them in the one-to-one peer tutoring setting.
- That it would be important to set up a mentoring process to assess progress and areas to address and improve.
- Could use cognitive training sessions for extra credit purposes within the school.

Trainer 3. When asked if the students that participated in the daily one-to-one personal cognitive training saw significant improvement in their academic achievement, the trainer stated that his students expressed significant improvement in both their grades and their motivation. He noted that all of the students that he worked with were exempt from the end of the year tutorials days for remediation, as well as, exempt from their final exams based upon grades, attendance, and discipline. He went on to say that the students' memory skills improved throughout the training. The key was that their focus improved. He stated that since they met every day, they were able to get deeper and further along in the program during that semester timeframe.

When asked if the students that participated in the daily computerized BrainSkills program saw significant improvement in their academic achievement, the trainer stated

that the one-to-one group was more excited and seemed to have more fun that the computer skill students. He stated that the biggest factor was a lack of motivation among the computerized training students. Those students that were more intrinsically motivated, seemed to experience greater success.

When asked what suggestions they would have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance, the trainer listed the following suggestions:

- Make the course an elective. That way, only students that want to be in the program are enrolled.
- Since teachers already do so much, that it would be better to have separate trainers or facilitators in charge of the training program.
- Teachers could do the Brain Games as a 5 minute warm-up each class period.
- It would be more cost effective for the teacher to work with the whole class at the same time rather than a one-to-one or small group program.
- The key would be to have teachers go through the LearningRx training, observe 10 or more hours with master trainers, to successfully test in the training, and complete 4-8 hours of one-to-one exercises as a trainer. He noted that these were the requirements to become a certified trainer.

Facilitator. One Caucasian, female facilitator of the online BrainSkills training was interviewed. It is important to note that while the facilitator is also trained through the LearningRx program to be a one-to-one brain trainer, in this setting, she was responsible for overseeing the computer lab classroom of BrainSkills students.

The BrainSkills facilitator was responsible for keeping track of all of the students' progress, the number of minutes on the computer, and the number of rounds completed. Each week, the student's time and the number of rounds completed were tallied to keep up with their progress. This process is how students were assigned their six-weeks grades for report cards. An example of the weekly chart is listed below in Table 3.

Table 3

Daily Class Period Record

TABLE 3					
Student Name	S1	S2	S3	S4	S5
Grade	10	10	10	12	9
Username	WISD1234	WISD1235	WISD1236	WISD1237	WISD1238
Password	12345	23456	34567	45678	56789
Date	1/2/2012	1/2/2012 - A		1/2/2012	1/2/2012
Time	0:19:47			Gibson	0:22:06
Rounds	10/29			0	16/32
Date	1/3/2012	1/3/2012 - A		1/3/2012	1/3/2012
Time	0:31:04			Survey	0:31:32
Rounds	19/37			0	22/40
Date	1/4/2012 - A	1/4/2012	1/4/2012	1/4/2012	1/4/2012
Time		0:28:25	0:28:46	0:29:33	0:31:16
Rounds		19/48	16/40	7/40	14/32
Date	1/5/2012	1/5/2012	1/5/2012	1/5/2012	1/5/2012
Time	0:28:35	0:36:23	0:23:58	0:31:26	0:32:'12
Rounds	7/24	28/44	17/27	7/29	16/41
Date	1/6/2012	1/6/2012	1/6/2012	1/6/2012	1/6/2012
Time	0:35:30	0:25:54	0:26:49	0:33:58	0:36:23
Rounds	8/36	15/35	14/23	11/41	13/34
Weekly Time	1:54:56	1:30:42	1:19:33	1:34:57	2:33:29
Weekly Rounds	44/126	62/127	47/90	25/110	81/179
Overall Time	1:54:56	1:30:42	1:19:33	1:34:57	2:33:29
Overall Rounds	44/126	62/127	47/90	25/110	81/179

Each week, the BrainSkills would also keep up with the daily and weekly high scores from each class period. This was used as a motivational factor to help students not

only try to beat their own high scores, but also help those students to compete against their classmates to try to win the daily and weekly high score award. An example of this information is included below in a weekly table from the facilitator labeled Table 4.

Table 4

Daily High Scores

TABLE 4							
Date	1st Period	2nd Period	3rd Period	4th Period	5th Period	6th Period	7th Period
1/2/2012	Student 1	Student 1	Student 1	Student 1	Student 1	Student 1	Student 1
1/3/2012	Student 2	Student 2	Student 2	Student 2	Student 2	Student 2	Student 2
1/4/2012	Student 3	Student 3	Student 3	Student 3	Student 3	Student 3	Student 3
1/5/2012	Student 4	Student 4	Student 4	Student 4	Student 4	Student 4	Student 4
1/6/2012	Student 5	Student 5	Student 5	Student 5	Student 5	Student 6	Student 7
Week	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
	53	71.85	67.64	72.7	69	57.83	78

When asked if the students that participated in the daily one-to-one personal cognitive training saw significant improvement in their academic achievement, the facilitator stated that the one-to-one group allowed for targeted training that was specific to each individual student's needs. The individual brain trainers also have the advantage of picking up on facial feedback and frustration from their student through body language and cues that provide immediate feedback to the trainer. She also noted that it was a perfect setting in the specific classroom that was provided in that it allowed for all of the individual brain trainers and students, as well as the computerized BrainSkills students to all be in the same room at the same time. The trainers use this setting to create more distractions to force students to be able to drown out all of the noises and activities around them and focus on the task at hand.

When asked if the students that participated in the daily computerized BrainSkills program saw significant improvement in their academic achievement, the facilitator

stated that the students that took the training seriously saw significant improvement and results. She noted that it was harder to establish buy-in from the students in the BrainSkills group. It was also difficult to measure whether or not she was getting a student's best effort. She also discussed how difficult it was to assign grades based on attendance, participation, number of minutes, and number of rounds completed. After a few weeks into the training, she established that a reasonable expectation for a student that was present each day would be to complete six successful rounds per day equally 30 rounds per week.

At the end of the semester, the facilitator logged all of the total minutes, the total rounds attempted, and the total number of rounds successfully completed by the group and sorted them by grade level. Also, the information was averaged together to calculate the average number of hours that were logged in the BrainSkills program for each student during the course of the semester and the cognitive training. That information is listed below in Table 5.

Table 5

Waskom High School Totals

Groups	# of Students	Rounds	Passed	Minutes	Avg. Hrs. Trained
WHS Totals	**61**	**102735**	**21176**	**152368.20**	**42**
9th Grade	**20**	**32377**	**7029**	**48748.85**	**41**
10th Grade	**18**	**29538**	**6350**	**44438.63**	**41**
11th Grade	**20**	**35605**	**6956**	**51693.35**	**43**
12th Grade	**3**	**5215**	**841**	**7487.37**	**42**

When asked what suggestions they would have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance, the facilitator listed the following suggestions:

- Establish incentives for the teachers, students, and administrators for buy-in. Especially for students to motivate them to try their hardest and do their best.
- Offer the course as an elective so that the students that are enrolled want to be in there and want to participate.
- For freshmen, have the class as a requirement to teach study skills and good habits to help meet their learning needs.
- For sophomores through seniors, offer the class as an elective.
- Consider whether or not it should be taught as a semester long course for ½ credit or all year for 1 credit. She suggested that it be taught for the full year.

The facilitator also listed advantages and disadvantages of considering this program in the school setting from the viewpoint of the staff member. Those notes are listed below as pro's and con's.

PRO's

- The program provides for steady hours.
- Learning from working with her colleagues and the other trainers.
- Enjoyed working with the students.
- Being able to leave her materials in the classroom for the next day.
- Having copies of materials that are needed on a daily basis.

CON's

- A lack of communication.
- Not knowing if students were not going to be present due to school activities of events.
- Not having a way to make up time missed due to absences.
- Not paid for time spent outside of the school day such as completing spread sheets and logs.
- Students that were not motivated to give their best effort. Lack of motivation.
- Whether or not the assessment test is valid and reliable for each student.

Students were told that the program would not affect their transcript or GPA since it was only administered as a pass/fail grade.

Themes from trainer interviews. The following themes emerged from interviewing the trainers based upon the three research questions:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
    - The trainers observed that students were able to focus and concentrate more as they progressed through the cognitive training.
    - The trainers observed that students were able to recall information faster and with more success as they progressed through the training.
    - The trainers reported that students were able to perform better and at higher speeds on two and three step process skills.
    - The trainers observed that students were perceived as more comfortable and to have less stress while working through cognitive exercises.

- The trainers observed that students seemed more motivated and progressed faster in the training when the students began to see success.

2. What components of online computerized cognitive training are perceived as practical and effective?
    - The trainers observed that the students, on average, were less motivated than the one-on-one cognitive training students.
    - The trainers observed that the students seemed more motivated and progressed faster in the training when the students began to see success.
    - The trainers observed that students were able to focus and concentrate more as they progressed through the cognitive training.
    - The trainers observed that students were able to recall information faster and with more success as they progressed through the training.
    - The trainers reported that students were able to perform better and at higher speeds on short and long term memory skills.
    - The trainers observed that students were perceived as more comfortable and to have less stress while working through cognitive exercises.
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?
    - The trainers recommended that the cognitive training should be included into a school curriculum. The trainers also recommended that the one-on-one cognitive training is preferred.
    - The trainers suggested that cognitive training could be used for remediation with students.

- The trainers stated that students could be assessed with early on pre-testing to identify areas of learning weakness or deficiencies.
- The trainers recommended that students be grouped by identified areas of learning difficulty for remediation and tutoring.
- The trainers suggested that the course could be offered as an elective.
- Most importantly, the trainers stressed the need for staff development to train the teachers in cognitive teaching strategies and activities if the training was to be implemented into a school curriculum.

Researcher Interviews

Three researchers were interviewed. All three researchers were Caucasian females. These researchers were employees of the LearningRx centers, but were also collaborating with Dr. Hill and Dr. Faison from Virginia State University on their follow-up from the 2011-2012 research project from the National Science Foundation. While the full research project and quantitative data has yet to be published, there is preliminary data available regarding the results from the study related to this qualitative case study of the project.

Preliminary information suggests that the one-to-one cognitive training group was showed more significant increases in more areas compared to the BrainSkills group that trained in the computer-based program. In addition to the data provided by the National Science Foundation found in Table 2, the researchers shared that the improvements and significant differences found from the one-to-one training can be attributed to the face to face motivation that comes from working one on one with a trainer/student setting.

When asked if the students that participated in the daily one-to-one personal cognitive training saw significant improvement in their academic achievement, the researchers stated that the one-to-one group saw an average growth of up to three years from the cognitive training. Information from both the pre-test and post-test functional MRI's and the cognitive assessments suggest that significant changes occurred in the frontal lobe organization due to training the brain. A notable exception to this seemed to occur in English as a Second Language (ESL) students in the study. ESL students improved more in the linguistic areas controlled by the right lobe than in the frontal lobe areas of organization. They state that this information could be used to accelerate language acquisition in ESL and Limited English Proficiency (LEP) students. This could have a large impact affecting states such as Texas with an increasing ESL and LEP populations.

When asked if the students that participated in the daily computerized BrainSkills program saw significant improvement in their academic achievement, the researchers stated that most of the students who underwent the functional MRI's showed an increased connectivity to the cerebellum at the base of the brain. These connections are responsible for cognitive processing and tasks. While the increase was not as significant as the one-to-one group, the increase and growth average of one to one and a half years was still significantly more than the control students with no cognitive training. There was an area in the BrainSkills group that increased more than the one-to-one group. That was an increase in processing speed which means that the brain functions faster. It was also noted that research shows that 80% of Special Education students have a weakness in

long-term memory. They suggest that the BrainSkills program can be customizable to target those areas of weaknesses in you student populations.

When asked what suggestions they would have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance, the researchers listed the following suggestions:

- Students need the one-to-one supervision to allow for motivation and immediate feedback.
- Provide staff development for teachers during the summer and allow teachers to incorporate strategies into their lessons.
- Do not provide the training as an after school program.
- Allow the training to take place early in the day while students are still motivated.
- If students and parents are not invested in the program, it will be tougher to get buy-in and cooperation to stay motivated.
- Could also examine peak performance times to coordinate with athletic training periods to allow for maximum results.
- They noted that physical education and physical fitness training is required in the public schools along with vision screenings and hearing screenings, but cognitive fitness training or screening is not a requirement.
- Suggested that staff development and training can even take place through an online, digital training session(s). This would help teachers discover more ways to implement the program into their curriculum and lessons.

Themes from researcher interviews. The following themes emerged from interviewing the researchers based upon the three research questions:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
    - The researchers suggested that a one-on-one cognitive training program is the preferred method.
    - The researchers suggested that English Language Learner (ELL) students could benefit in the area of language acquisition skills.
2. What components of online computerized cognitive training are perceived as practical and effective?
    - The researchers suggested that connectivity to the cerebellum could be increased helping to increase processing skills and speeds.
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?
    - The researchers suggested that a one-on-one cognitive training would help to increase student motivation.
    - The researchers also suggested that cognitive training could also be implemented in coordination with athletic training and exercises for maximizing results.
    - Most importantly, the researchers stressed the need for staff development to train the teachers in cognitive teaching strategies and activities if the training was to be implemented into a school curriculum.

Summary

Key findings across the different roles in the research project included a need for cognitive training, that there are significant gains to be made, that the students saw the benefits from a form of training, and the need to educate and train teachers within the schools to implement strategies in the classroom. There is a need to identify through both teaching styles and learning styles how students may best be served and how student needs may be met to help decrease learning gaps and increase the learning processes needed for a student to be successful. The following chapter will conclude by offering conclusions, implications, and recommendations for future practice and further research.

Chapter V

Summary, Conclusions, Implications, and Recommendations

The purpose of this qualitative single instrumental case study was to examine practical, effective applications of implementing a cognitive training curriculum into the schools and into the classrooms with the intent of helping all students increase student achievement. By implementing a cognitive training curriculum into the classrooms, the goal of helping high school students increase student achievement may be realized by targeting specific areas of learning deficiency, assertively focusing on intensive remediation in those areas, and ultimately decreasing or removing those areas of weakness in the learning altogether.

This chapter discussed an overall summary of the study including an overview of the problem, the purpose of the study, the research questions used to guide the study, a review of the study's design, and a summary of major findings. Also included in this chapter were conclusions, implications for practice in the field of education, any recommendations for future research, and concluding remarks.

Summary of the Study

This qualitative single instrument case study examined the 2011-2012 National Science Foundation research project which involved two different types of cognitive training at the high school level in a rural, 3A high school in East Texas. The case study analyzes the effectiveness of the two types of cognitive training and whether or not the training can be implemented into a school curriculum and the classroom setting. The case study included interviews from students that participated in the one-to-one cognitive training with a personal brain trainer and students that participated in a computer-based

cognitive training in a computer lab classroom. The case study also included interviews from teachers in each of the four core areas of Math, Science, English Language Arts, and Social Studies. Also included in the teacher interviews was a teacher in the Career and Technology Education area of Family Consumer Sciences. Interviews were also conducted that included the personal brain trainers from LearningRx, the computer-based BrainSkills facilitator, and researchers involved in the 2011-2012 National Science Foundation project.

Brief overview of the problem. Whether you are a classroom teacher or a coach, both look for ways to increase student, or student-athlete, success. The same is true as an administrator. No matter what the role or what the title may be, educators seek the most effective strategy to increase learning. There are numerous companies or organizations that claim that their software or their packages are the way to go (Bryan, 2014). The concern for the public school administrator with little or no money to spend in additional areas is how they can get the most bang for their buck to help their students succeed (Rode et al., 2014).

In a time where school districts have decreased revenue and funding from the state, many districts have decreased staffing which leads to larger classes (Stutz, 2013). The question then becomes how we can effectively and efficiently utilize our programs and our personnel to maximize student success. The cognitive training industry is a multi-million dollar industry (Aamodt & Wang, 2007) that is focused on their profits. That conflicts with the goal of schools that are focused on cutting costs while still maintaining student success (Stutz, 2013).

Purpose statement. The purpose of this qualitative case study was to examine practical, effective applications of implementing a cognitive training curriculum into a school with the intent of helping all students be successful. By using cognitive training programs in the classroom, the intent of helping high school students increase student achievement may be realized by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

A cognitive training program was defined as any program that attempts to help a student learn faster, easier, and better (Hill, 2012). The research focused on targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

Research questions. The following research questions guided this study:

1. What components of one-on-one personal cognitive training are perceived as practical and effective?
2. What components of online computerized cognitive training are perceived as practical and effective?
3. How can cognitive training be implemented in the curriculum to help enable teachers to affect learning outcomes and improve student performance?

Review of the study design. The research design in a qualitative study includes committing extensive time in the field, engaging in a complex, time-consuming process of data analysis, writing narrative passages, and using a form of social and human science research (Creswell, 2013). Using a qualitative single instrumental case study, the researcher focused on an issue of learning difficulties and how to improve student

achievement in the classrooms and school. This study was conducted using a qualitative design methodology and holistic analysis to gather data on the use of brain-training with all high school students in grades 9-12 at a small 3-A rural school district located in East Texas. Also, documentation, observations, and interviews will be used to gather information and data in regards to their attitudes toward the cognitive training activities. The data that was gathered included data from three randomly chosen groups: the control group, an experimental group that received personal one-to-one training from an instructor five times per week for 45 minutes each day, and another experimental group that received online computerized cognitive training from the BrainSkills cognitive training curriculum five times per week for 45 minutes each day. This data was used to measure the academic progress of each group of students from September to May, or one school year.

The Gibson Cognitive Skill Test, which consists of seven subtests, was administered as a pretest and posttest to each student in all three groups. The seven subtests covered the following areas: brain processing speed, measuring working memory, word attack skills, visual processing, segmenting, auditory analysis, and logic and reasoning. In addition to the Gibson Test, each student was administered the Attitudinal Measurement Test which is measured by a Likert scaled instrument. Randomly selected students in each subgroup were given a functional MRI (fMRI) to measure brain activity for certain portions of brain exercise activities and skill tests. Students' six weeks grades and standardized assessment scores were also analyzed with programs provided to school districts by their regional service centers such as Pearson and Data Management software for Assessment and Curriculum (DMAC).

Summary of major findings. Findings from the study included whether or not the cognitive trainings were effective and what areas of learning showed significant gains or improvements. The findings were also broken down into the two different types of cognitive training; the one-to-one personal cognitive training and the computer-based cognitive training software program. Finally, the findings included information gathered and compiled from the personal interviews with the participants and the researchers. This information focuses on how a cognitive training program could be effectively and efficiently implemented into a school setting in the classrooms and throughout the curriculum.

First, the research showed that the personal one-to-one cognitive training from the LearningRx brain trainers produced results as high as three years' worth of growth from the pre-test assessments at the beginning of the study and the post-test assessments at the conclusion of the training and study. The preliminary results from the study indicated significant gains in cognitive skills for those students placed in the one-to-one LearningRx program, as compared to the control group, in 9 of the 12 cognitive areas. Those 9 areas included working memory, visual memory, short-term memory, long-term memory, word attack, auditory segmenting analysis, auditory drop analysis, auditory processing, and matrix reasoning. Results found that the one-to-one LearningRx students had the most significant gains in the areas of word attack (decoding) and auditory analysis (phonemic parsing). These two skills are particularly important areas used in reading.

Secondly, students in the second experimental group showed average gains of one year to one and a half years from beginning to end. The preliminary results also

indicated significant gains in 4 of the 12 cognitive areas for those students placed in the computerized BrainSkills training group, as compared to the control group. Those areas of improvement included working memory, visual memory, word attack, and auditory segmenting analysis.

Finally, all of the participants indicated suggestions for implementing a cognitive training curriculum into the schools. While these suggestions and ideas were diverse, there were certainly some themes that developed to include staff development, ideas for teacher implementation, identifying areas of need for each student to help tailor the instruction to fit their needs, and examining the cost efficiency of implementing the most effective program to meet your needs.

Conclusions

One study in Great Britain stated that an estimated 19 million dollars were spent last year on cognitive training games and software in the United States alone (Bang Goes the Theory, 2011). The study went further to include thousands of participants in a six-week study that showed minimal to no difference between adults who underwent six weeks of cognitive training activities versus the control group that merely used the computer as an internet search tool. Memory and problem solving skills from pre and post tests were nearly identical between the two groups.

For this reason, it is important to make sure that the training is research-based and effective. From students, teachers, trainers, facilitators, and researchers, all indicated suggestions based around the following five areas;

1. A key would be to train teachers in effective strategies of cognitive training and how they could effectively implement those strategies in their teaching and lesson

planning. Staff development would be crucial to ensure that teachers were knowledgeable and comfortable in implementing these practices in the classroom to meet the needs of their students.

2. That teachers could use the one-to-one strategies at the beginning of each class period as a warm-up exercise or bell ringer. This would allow the teacher to target one area of need each day and reach an entire classroom of students within a five minute warm-up. These could also be utilized as test-taking strategies to help students gain confidence and increase success levels.
3. It would be very beneficial to use cognitive assessments as pre-tests to identify a student's learning styles and areas of weakness. This would allow teachers to help meet the individual needs of their students by differentiating the instruction and varying the activities in the classroom.
4. As different areas of need are identified with their students, teachers would be able to group those students together for small group instruction or even pull-out instruction to focus the cognitive training on those areas that are needed most. This would allow teachers to customize the teaching to meet the needs of their learners.
5. The most cost effective ways to implement a cognitive training program into the schools would be to train teachers to incorporate the training into their teaching and to utilize a computer-based software program such as BrainSkills. While one-to-one training showed significantly better results, it would not be cost effective to hire individual brain trainers that places the student-teacher ratio at 1:1 for the cognitive training program.

Implications for Practice

What is the relevance? There is still much debate that needs to be researched to challenge whether or not cognitive training actually works. More importantly, it is crucial to challenge specific companies and cognitive training activities to see which ones actually do work and are worth the money spent on them. In a time where school districts are held to higher accountability standards than ever before, many districts may be interested in investing monies toward a program or programs that will effectively increase their student success in the classroom and on standardized tests. However, it is also important to note that those same school districts and systems are being required to stretch their budget further than ever before and do more with less funding.

Implications revolve around examining the research to identify whether or not a program is effective. Secondly, the program must be designed to fit the school's needs for implementation. Teachers must be trained in cognitive training exercises and how to incorporate those strategies into their classroom. This can be done at the beginning of class as a warm-up and it can also be done with individual or small group tutoring to work on study skills, test-taking strategies, and comprehension strategies.

An area that could truly impact education in the state of Texas, and other states with a growing Hispanic population, is the area of students with language barriers. A notable exception to the study seemed to occur in English as a Second Language (ESL) students and Limited English Proficiency (LEP) students. These students improved more in the linguistic areas controlled by the right lobe of the brain. This could have a significant impact on how ESL and LEP students may be taught to help accelerate their

language acquisition and comprehension in order to help them be more successful and at a faster rate than before.

Recommendations for Future Research

With school districts on tighter budgets, there needs to be more research done in the areas of cognitive training and how it can specifically impact student success on standardized testing. Before districts invest thousands of dollars into programs or brain trainers to work with their students, the most crucial research needs to take place to determine first if cognitive training is truly effective and secondly, which method or methods are the most cost effective and successful in the school setting.

Further research needs to be done on the effectiveness of training teachers in cognitive training strategies. A whole new area of staff development could emerge taking what has been an area of training in the private business sector and crossing the bridge into public education. If significant gains gain truly be made, why wouldn't we train our teachers in those techniques? Also, the training would need to be altered from what has been a focus on one-to-one instruction to becoming small group or even whole group instruction.

Further research would truly be needed in the area of English as a Second Language (ESL) and Limited English Proficiency (LEP) students. There were identifiable areas of improvement that differed from the rest of the population in the research project when it came to ESL and LEP students. Research would need to be done to examine why these students had more gains in the right lobe areas of linguistics rather than the frontal lobe area of organization. Should this area of linguistic acquisition be developed first so that the other areas of cognitive learning may also be developed? With

an increasing Hispanic population in the classroom, this is a developing need area that needs to be addressed to help meet the needs of ESL and LEP students.

Concluding Remarks

A key to helping a student be successful is the development of a positive relationship of caring and trust. Those students that went through the one-to-one training appreciated and respected how their trainer pushed them to get better and worked them harder than they had worked before. Some students and trainers indicated that they still kept in touch and checked on each other three years after their training had concluded.

As a former teacher and a coach, I sincerely believed that if I could get my students to believe that they could do something, that was half the battle of helping them to be successful and reach their goals. When a student has confidence, they will perform better in pressure situations whether that is in the classroom, on a test, or in a game. Each of the students that were interviewed indicated that they felt more focused, were more organized, could help remember information better, and that they were more focused than before. The data showed significant improvements from beginning to end. Whether or not the brain can truly be exercised as a muscle may still be up for debate, but when a student trusts that something helped them improve, that belief and confidence can make all the difference.

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List of Appendices

Appendix A

National Science Foundation Letter of Invitation

Waskom High School Parents/Guardians –

A groundbreaking study is about to begin at our school that has the potential to significantly help every one of our high school students, and provide valuable information to the fields of science, education and medicine.

The research is part of ongoing efforts to determine if cognitive skills training can help students do better in STEM (science, technology, engineering, math) fields. Virginia State University Psychology Chair Dr. Oliver Hill is leading the study, and after heading up similar research projects in the past he testified before a congressional subcommittee, “This approach has the potential to revolutionize education …”

Now Waskom Independent School District gets to benefit from an even bigger, more prestigious study, thanks to a $1 million grant from the National Science Foundation. The first part of the study will take part through the end of the school year, mostly at and during school, with doctors and researchers from Virginia State University overseeing all aspects of training and monitoring. Basically they will be trying to determine how cognitive training can help kids do better in math and science.

Why is this such a remarkable opportunity for Waskom Independent School District? Every Waskom High School student will take a test to evaluate his or her cognitive skills, or the mental tools we all use to think, learn, reason, read, remember and pay attention. These skills include things like memory, attention, logic and reasoning, auditory and visual processing and processing speed. This test alone will provide valuable information for our teachers and families regarding each student’s strengths and weaknesses, and will give us the insight we need to help strengthen those skills to improve grades and performance.

After this initial testing the students will be randomly placed in three groups:

Group A: This is the control group. These students will receive no extra training, and will simply continue on with the same quality academic instruction that’s now scheduled for them.

Group B: These students will receive 15 weeks of online cognitive training that is targeted at strengthening cognitive skills. At the end of the research project, ALL Waskom high school students will have FREE access to this valuable training for a full year.

Group C: This group will undergo 15 weeks of one-to-one cognitive skills training with their own personal brain trainer from LearningRx (www.learningrx.com). This training will take place at school for one hour each day. The training consists of fun, but intense, game-like brain exercises that work underlying mental skills like attention and memory. In a private setting, this training has been shown to increase IQ by an average of 15 points – leading to better grades and reading ability, reduction or elimination of learning struggles, improvements in sports and the arts, drastic reductions in the amount of time needed to complete homework and schoolwork, more overall opportunities, and a huge jump in self-confidence.

Students from each of the three groups will be **randomly** chosen to undergo functional magnetic resonance imagining (fMRI) both before and after the 15-week period. These brain scans are noninvasive, harmless, and will only be given with parental permission. The images will provide significant, physical proof of how the brain has changed and improved because of the cognitive skills training. **Each student who completes this part of the study will receive $200 to help cover transportation costs to LSU-HSC in Shreveport where the scans will take place.** They will also get a disk with a copy of their brain scans.

I know you have questions. **We've scheduled a Parent Information Night at the high school in the cafeteria at 6:30 p.m. on Monday, October 17th**. Administrators, researchers, cognitive skills experts and brain trainers will be on hand to explain more about this opportunity to significantly help our students and answer your questions. We strongly encourage you to attend. In the meantime, you may be hearing more about this impressive study in the media. If you'd like to learn more now, please view the *National Science Foundation Reese Educational Research Project – Assessing the Efficacy of Cognitive Training on the Mathematics and Science Performance of Middle and High School Students Outline* or view the *NSF Study Summary*.

This is a venture that I am so excited our students will be a part of. It comes with no financial cost to our schools, our district or our families but has the potential to dramatically improve our future. The testing and valuable in-person and online training opportunities could prove hugely beneficial in raising not only our standardized test scores, but also the ability and potential of every single one of our students. This is a valuable opportunity for our students and I look forward to your participation and support.

Parent Information Meeting
Monday, October 17th
6:30 pm
In the Cafeteria

Stuart Musick
Principal

Appendix B

National Science Foundation Letter of Results

Dear parents of

An amazing opportunity to help every one of our students is underway at Waskom ISD. Thanks to a generous grant from Cog1st, every child in 1st through 12th grade has completed a cognitive skills screening, through LearningRx, called the Gibson Test of Brain Skills.
Your child's individual results are now available for you to review.

Why is this test so important? Because it doesn't measure academic knowledge; it doesn't determine how much history our students know, how their spelling is, or if they can do long division. In many ways, it's a much more valuable test; it measures cognitive skills, or the underlying mental tools used to think, learn, reason, remember, and pay attention.

These results will help us – the teachers at Waskom High School and parents at home – help your child become a faster, better learner. The screening measures things like auditory and visual processing, logic and reasoning, attention and memory skills and processing speed. If any one of these skills is weak it can slow learning, lead to a bottleneck of information in the brain, or result in ongoing learning struggles.

The Gibson test has determined which skills are strong and which are weak for every child in our district who took this online screening. Now we can focus on strengthening any weak skills to make learning easier for struggling students and for advanced students alike.

Training continues at Waskom ISD for teachers and staff regarding this testing. We're learning how to interpret individual student results and how to work with the students to make weak skills stronger with specific, targeted mental exercises.

- To learn more about this testing, and the importance of determining each child's unique learning skills profile, go to www.gcstest.com.
- From this website, you can access and download your child's own cognitive skills report by clicking on "Login" in the upper right hand corner.
- You will be prompted for a User ID & Password.
- Enter his/her User ID: WISDH _ _ _ and Password (their six digit student identification number /lunch number) and you will be directed to your child's confidential evaluation results.

We believe this is an amazing opportunity to give our students a considerable academic boost at no cost to our district or parents. We look forward to working with you to use this information to strengthen the skills that will lead to faster, easier, more efficient learning for your child. Please

watch for more information coming soon. If you have any questions, please feel free to contact us.

Appendix C

National Science Foundation FERPA Letter

Wednesday, December 14th, 2011

To: Dr. Oliver Hill
Virginia State University
Cc: Ms. Donesa Walker
Learning Rx
From: Stuart Musick
Principal – Waskom High School

The following section is an excerpt from the Family Educational Rights and Privacy Act (FERPA):

> The Family Educational Records Protection Act (FERPA) was originally passed in 1976 and has been amended many times since. Its purpose is to guarantee parents free access to student school records. Under provisions of the Act, the Secretary of Education has the authority to withhold all federal funding to institutions that do not make school records available to a student's parents. There are exceptions to this rule, such as authorizing the transfer of transcripts when a student changes schools or applies for admission elsewhere, **for researchers doing studies of educational techniques and practices when such research can be conducted confidentially and anonymously**, for state or federal officials conducting audits of public assistance programs, or in the course of normal business.

Waskom High School, along with Learning Rx, hosted a parent meeting on Monday, October 17th, 2011, to introduce and kick-off our National Science Foundation (NSF) research study and grant that we will be participating in for the Spring, 2012, semester. Letters were mailed out, e-mail contacts were made, and public notices posted in order to disseminate information ahead of time and to follow-up after the meeting in order to seek the volunteer families that chose to participate in the study and volunteered to participate, if randomly chosen, in the Functional MRI's (fMRI).

After the initial random selection process that separated students into three groups:

- Group A – Control Group
- Group B – BrainSkills Group
- Group C – One-to-One w/ Brain Trainer Group

Families were then issued letters with consent forms notifying them of which group they were placed in and asking for the parent signature in order to confirm one of three options:

- Option 1 – I agree that my child may participate in the study and in the group chosen.
- Option 2 – I do not wish to have my child participate in Group B or Group C, but agree that they may participate in the research study.

- Option 3 – I do not wish for my child to participate in the study in any way and do not wish for their anonymous survey or cognitive screening results to be used for this project.

Families were issued these letters and opportunity to opt out on two different occasions. Any student that did not specifically opt out by returning the consent form indicating that they did not wish to participate was included in either the BrainSkills Group B or in the Control Group C.

Due to "*in loco parentis*" established in the FERPA section to allow the school to utilize "*studies of educational techniques and practices when such research can be conducted confidentially and anonymously*" and is deemed in the best interest of the student(s).

We look forward to working with the researchers from Virginia State University and with the team from BrainSkills and Learning Rx to see how we can help the students of Waskom ISD, along with future students and teachers, achieve their fullest potential for success in learning.

Sincerely,

Stuart Musick
Principal
Waskom High School
903-687-3361 (Ext. 1300)
smusick@waskomisd.net

Appendix D

National Science Foundation Letter of Conclusion

Monday, April 23rd, 2012

Dear WHS Parents/Guardians,

The cognitive training aspect of the National Science Foundation Study at Waskom High School, underway since January 2nd, is now nearing an end. We are very interested in feedback from parents of students participating in either the one-on-one cognitive training or online computer-based BrainSkills cognitive training to see if you have noticed any changes in your child. This type data is very important to the researchers.

Please complete the attached Parent Survey and have your child return it to their brain trainer or monitor by **Friday, April 27th, 2012**. We appreciate your time and effort.

To celebrate the hard work of all students participating in cognitive training, we invite you to join your child for a program review, demonstration, and **breakfast on Friday, May 18th, from 7:30 am-8:30 am in the Waskom High School Library**. Some of the students will participate in a timed competition, reciting US presidents forward and backwards, with the winner receiving a cash prize. Brain trainers from LearningRx and staff from LSUHealth Center will be on hand to meet you, answer any questions and also schedule final f- MRI's for those of you with children in that aspect of the study. Coffee, juice, and donuts will be available.

The researchers' goal was for students in either of these two study groups to complete 70 hours of cognitive training. All students at Waskom High School were cognitively tested in October, 2011, and all students, including "Control Group" students (who did not participate in any form of cognitive training) will be re-tested next month to compare results for pre- and post-cognitive training. Seniors will post-test on May 14th and the 9th, 10th and 11th grade students will post-test on May 21st. Parents will be given access to these test results with students' final report cards.

At the conclusion of the National Science Foundation (NSF) study, all students at Waskom High School will have access to the online Brain Skills cognitive training program and we hope that parents will encourage their children to take advantage of the opportunity to continue cognitive training over the summer.

Thank you and we look forward to seeing you on Friday, May 18th, at 7:30 am for breakfast.

Sincerely,

Donesa Walker
Owner/Executive Director
LearningRx, Shreveport/Bossier City, LA

Stuart Musick
Principal
Waskom High School

Appendix E

Gradings and Expectations

Brain Skills

Students,

The researchers from Virginia State University have informed us that they need a minimum of 70 active hours per student, for their data collection. Taking school holidays into account, we have estimated this out to be a minimum of 35 minutes of active time per class period. Seeing as all classes are 47 minutes, at a minimum, 35 minutes of active time is more than achievable. At the beginning of each week, you will be told how many hours you should have completed by the end of your class period by the end of that week. If you are absent, or miss class for some reason, you are responsible for making up that time! You have until the end of the 6 weeks to be caught up. This can be done at home, or anywhere you have computer and internet access. If you do not have computer and internet access anywhere other than school, you may come in at lunch to make up time or get with me to make arrangements for before school. Also, if you do not have computer and internet access other than at school, you should be working hard in class everyday to maintain your time. I am not required to offer my time before school. However, I will be available for those who are doing their part, but still need more time. Attached you will find a chart that shows how many hours you should have regardless of attendance, how many hours you should have based on your attendance, and how many hours you actually have. Your grade is based on your active time. However, if we see that you are just logging time and not passing rounds, your grade will suffer. If you have any questions or concerns please feel free to ask me. Thank you for your cooperation and I hope we have a great rest of the year!

Ali Landry
LearningRx

Appendix F

Teacher Surveys

Teacher Survey Brain Training						4/16/2012
students with a plus sign (+) in each column for Improvement. Leave blank if you have seen No Improvement/ No Change						
Study	Attentiveness	Completion of	Memory/Recall	Behavior/	Confidence/	Comments
Group		HW & Classwork	of Information	Discipline	Self-Esteem	
C						
B						
A						
C						
C						
B						
B						
B						
C						
B						
B						
A						
A						

Waskom High School
Teacher Survey-Cognitive training

Teachers: Please complete for any of your students who participated in the cognitive training & return to Aly Landry by May 12, 2012. Thank you!

Thank you for your cooperation with your students who participated in the 1-1 and online cognitive training for these past several months. We are interested in teachers and parents' feedback and observations of any changes you have observed as a result of cognitive training. Thank you for taking the time to provide your valuable feedback.

1) Have you noticed any changes in your student since cognitive training began? Please respond "Yes" or "No" and provide specifics where applicable.

   a) Class work/Homework Completion and Study Habits:_____

      _____

   b) Attentiveness:

      _____

      _____

   c) Memory/ Recall of Information:_____

      _____

   d) Cooperation/Motivation:

      _____

      _____

   e) Self-esteem/Attitude:

      _____

      _____

   f) Behavior/Discipline

      _____

      _____

2) Comments:_____

_____

_____

Completed by:

_____	_____	_____
Teacher Name	Teacher Signature	Date

Appendix G

Parent Surveys

Waskom High School
Parent Survey-Cognitive training

Parent/Guardian: Please complete & have your student return to their brain trainer/monitor by by Thursday April 19, 2012.

The National Science Foundation study at Waskom High School is more than halfway over. We are interested in parents' feedback about the process and observations of any changes to your student as a result of cognitive training, if your child is in either the online BrainSkills group or the one-to-one group. Please share any comments, concerns or contact the office with any questions. Thank you for taking the time to provide your valuable feedback.

3) Have you noticed any changes in your student since cognitive training began? Please respond "Yes" or "No" and provide specifics where applicable.

   b) Study habits/ Homework completion_____

   c) Self-esteem/Attitude? _____

   d) Cooperation/Motivation?_____

   e) Memory/ Attentiveness? _____

   Comments:
   _____

   _____

4) Any concerns about Cognitive training or any other aspect of the NSF Study?

   _____

   _____

   Completed by:

   _____ _____

   Parent/Guardian Name Parent/ Guardian Signature

Appendix H

IRB Consent Form for Interview

Lamar University
Department of Educational Leadership
College of Education

SUBJECT CONSENT TO PARTICIPATION IN RESEARCH

Title of Study: **COGNITIVE TRAINING IN THE CLASSROOM:**

A QUALITATIVE SINGLE INSTRUMENT CASE STUDY

Name of Investigator(s): **Stuart Andrew Musick**
Phone Number(s): **903-948-1034**

I understand that I am agreeing to participate in a research project and that the purpose of the study is to identify the effects of cognitive training in the classroom setting. I will be asked a series of interview questions and the investigator will record my answers. My name will not be used and the confidentiality of my responses will be protected. The entire procedure will take 30-60 minutes. My participation will take place in a private area with only the researcher present. I can decline to answer any question.

Purpose

The purpose of this qualitative case study is to examine practical, effective applications of implementing a cognitive training curriculum into the schools and into the classrooms with the intent of helping all students increase student achievement. By using cognitive training programs in the classroom, the intent of helping high school students increase student achievement may be realized by targeting areas of learning deficiency, assertively focusing on intensive remediation, and ultimately decreasing or removing those areas of weakness in the learning altogether.

Risks

The interview is entirely voluntary and does not entail any foreseeable risks. I understand that I may quit at any time. All data will be maintained in a locked file in the investigator's office for one year and then shredded. Consent forms will be forwarded to:

The Office of Research
John Grey Library
Box 11019
Lamar University
Beaumont, Texas 77710

Benefits

Benefits of participation may include a contribution to scholarly research that identifies issues of cognitive training. There will be no direct benefits to the subjects.

Participation

I understand that my participation in this study is voluntary and that I may withdraw from the study at any time. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled. I understand that I will not be compensated for my participation. An offer has been made to answer all of my questions and concerns about the study. I will be given a copy of the dated and signed consent form to keep.

Signed_____ Date_____

Investigator_____ Date_____

If you have any questions about the research or your rights as a subject, please contact

The Chair, Institutional Review Board, 409-880-8933.

Appendix I

Guided Protocol

COGNITIVE TRAINING IN A SCHOOL CURRICULUM:

A QUALITATIVE SINGLE INSTRUMENT CASE STUDY

Interview Questions

1. Did the students that participated in the daily one-on-one personal cognitive training for 45 minutes per day see significant improvement in their academic achievement compared to students that did not receive the one-on-one personal cognitive training?
2. Did the students that participated in the daily online computerized cognitive training from the BrainSkills cognitive training curriculum see significant improvement in their academic achievement compared to students that did not receive the daily BrainSkills cognitive training?
3. What suggestions do you have to implement a cognitive training curriculum in the school's classroom setting to help enable teachers to effect learning outcomes and improve student performance?
4. As a student, would you participate in a cognitive training class again if offered?

Appendix J

IRB Approval

Memorandum

Office of Research & Sponsored Programs
Institutional Review Board
Lamar University

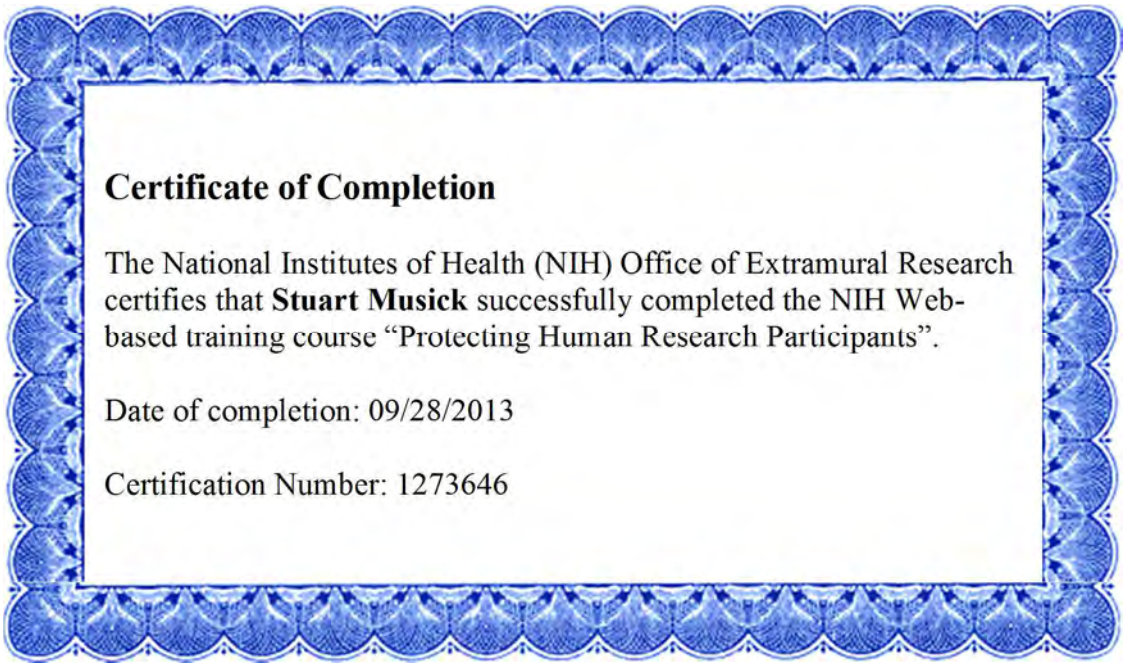
Date: April 2, 2015
To: Stuart Musick
From: Office of Research & Sponsored Programs Administration
Re: Request for approval by IRB

Your project, “Brian Training in the Classroom: A Qualitative Single Instrument Case Study” was reviewed and approved. It qualifies for exemption because the research employs standard methods and procedures for testing and educational purposes, involves minimal risks to subjects, and makes participation strictly voluntary. This approval is for a period ending one year from the date of this memorandum. Please make timely submission of renewal or prompt notification of project termination. Your IRB # is 73415139.

Remember to obtain approval from the Institutional Review Board before instituting any changes in the project. The Board wishes you every success in your research endeavor.

Appendix K

Certificate of Human Subject Research Training



Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Stuart Musick** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 09/28/2013

Certification Number: 1273646

Appendix L

Letter of Permission – Waskom Independent School District

Waskom Independent School District
980 School Avenue * P.O. Box 748 * Waskom, Texas 75692

Thursday, May 07, 2015

To whom it may concern –

As a part of his coursework and dissertation, Mr. Stuart Musick has my permission to use the name and information from Waskom High School and Waskom ISD in reporting his data and findings. This information includes data from the 2011-2012 school year and the National Science Foundation research project that was conducted at Waskom High School while Mr. Musick was Principal. This information also includes data and information from his recent interviews and current case study as a follow-up to that research project from 2011-2012 to be included in his dissertation. No student names, staff names, or personal information should be used.

Sincerely,

Jimmy E. Cox

Jimmy E. Cox
Superintendent of Schools
Waskom ISD
903-687-3361 (Ext. 1000)
jcox@waskomisd.net

"We Are... Waskom!!!"
903-687-3361 (Ext. 1000) * Fax # 903-687-2897

Appendix M

Letter of Permission – Virginia State University

VIRGINIA STATE UNIVERSITY
PETERSBURG, VIRGINIA 23806

Oliver W. HILL, Jr., PH.D.
DEPARTMENT OF PSYCHOLOGY

(804) 524-5969
ohill@vsu.edu

Thursday, May 07, 2015

To Whom It May Concern:

As a part of his coursework and dissertation, Mr. Stuart Musick has my permission to use the information from the Waskom High School and Waskom ISD preliminary data from the 2011-2012 school year and the National Science Foundation research project that was conducted at Waskom High School while Mr. Musick was Principal. This information and data will be used for his current case study as a follow-up to that research project from 2011-2012 to be included in his dissertation.

Sincerely,

Oliver W. Hill, Jr., Ph.D.
Professor of Psychology

Biographical Note

Stuart Andrew Musick is a 1990 graduate of Stephen F. Austin State University with a Bachelor of Science Degree in Education majoring in Kinesiology and Science. In 1991 he received his Master's Degree from Sam Houston State University with a M.Ed. in Kinesiology and a minor in Administration. In May of 2008, he received his administrative certification after completing the Principal Preparation Program through Stephen F. Austin State University. In June of 2010, he completed his Superintendent certification, also through Stephen F. Austin State University. Mr. Musick began working on his Doctoral Degree in the Fall of 2012 and graduated with his Doctorate of Education in Educational Leadership through Lamar University in May of 2015.

Stuart "Stu" Musick is in his 24th year as an educator. During those 24 years, he has served as a teacher, a coach, a middle school principal, a high school principal, and now a superintendent. During his 17 years in the science classroom, he taught Physics, Chemistry, Applied Physics, Principles of Technology, and Integrated Physics and Chemistry (IPC). Along with 14 years of high school coaching experience, he also coached baseball at the collegiate level for 2 years at Stephen F. Austin State University and East Texas Baptist University.

He, and his beautiful wife Lauren, were married in June of 2007. Lauren was the Children's Minister at Immanuel Baptist in Marshall for 12 years. In April of 2009, they celebrated the birth of their first child, Emma! Finally, they celebrated the arrival of their second baby girl, Brennan, in December, 2011!

Permanent Address:	604 North Magnolia Avenue, Hubbard, Texas 76648
Style manual designation:	*Publication Manual of the American Psychological Association, Sixth Edition*
Typist:	Stuart Andrew Musick