Equipping Students' Minds with A Cognitive Training Program for Preventing School Violence

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Abstract
This chapter discusses the impact that cognitive deficits have on academic frustration which leads to an increase in distributive and violent behavior in the classroom. Specifically, there are a disproportionate number of learners who are served under the Individuals with Disabilities Act (IDEA) who are referred to law enforcement, restrained, suspended, drop out, expelled, and are bullied. Equipping Minds Cognitive Development Curriculum (EMCDC) is a cognitive training program which has demonstrated improvement in academic skills, executive functioning skills, fluid reasoning skills, and verbal skills in students with neurodevelopmental disorders. By equipping schools to increase cognitive abilities and facilitate academic success, frustration in the classroom will be decreased resulting in a reduction of violent behaviors and provide a safe learning environment.

Keywords
Cognitive Training, Working Memory, Executive Functioning, Mediated Learning, Feuerstein, Equipping Minds Cognitive Development Curriculum, Specific Learning Disorder

Introduction

It should not be surprising to learn that 80 % of behavior incidents occur in the classroom where academic instruction and academic frustration coincide (Kentucky Department of Education, 2019). Students may have difficulty following multi-step directions, exhibit poor self-regulation, inattentiveness, disorganization, impulsive behavior, and difficulty planning. These cognitive deficits negatively impact a student's success in school (Alloway et al., 2010b; Carretti et al., 2009; Cramer et al., 2014) leading to academic failure and frustration in the classroom which is a significant predictor of students who exhibit delinquent, disruptive, and aggressive behavior (Gray, 2000; Maguin & Loeber, 1996; Rodney et al., 1999; Kaufman et al., 2000). This chapter[1] describes the importance of addressing cognitive deficits by implementing the Equipping Minds Cognitive Development Curriculum (*EMCDC*), a research and evidenced-

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based cognitive training program (Brown, 2018a; Brown, 2018b) to reduce or prevent violence-based behaviors by children in schools. The author has published research using the *EMCDC* demonstrating far transfer effects to verbal abilities, non-verbal abilities, IQ composite, and academic skills. For this reason, the author suggests that the missing component to improve cognitive deficits and academic skills is the inclusion of a cognitive training program, *EMCDC*. By equipping schools to increase cognitive abilities and facilitate academic success, frustration in the classroom will be decreased resulting in a reduction of violent behaviors and promoting school safety.

EMCDC has been used with students diagnosed with neurodevelopmental learning disabilities: specific learning disorders (SLD), attention deficit hyperactivity disorder (ADHD), autism spectrum disorders (ASD), speech and language disorders, and intellectual abilities, which are served under the Individuals with Disabilities Act (IDEA) or Section 504 of the Rehabilitation Act (Brown, 2018a; Brown, 2018c). Learners with diagnosed neurodevelopmental disorders have deficits in cognitive functions, such as, working memory, attention, executive functions, processing, and fluid reasoning which impact reading, writing, mathematics, and behavior (de Vries et al., 2021; Alloway, 2006; American Psychiatric Association, 2013). The chapter includes an overview of the *EMCDC*, the author's quantitative research study using the *EMCDC* with SLD learners, seven case studies of learners with neurodevelopmental disorders, and the implementation of *EMCDC* in the classroom for all learners.

School Climate and Safety

In 2018-2019, 7.1 million or 14 % of students received special education services under IDEA through an Individualized Education Plan (IEP) or 504 Plan (National Center for Education Statistics, 2020). The U.S. Department of Education, Office for Civil Rights, collected data in 2015-2016 and 2017-2018 on *School Climate and Safety*. The purpose of the report was to evaluate the safety of students at school and the number of serious offenses, referrals to law enforcement, expulsion, out of school suspension, harassment or bullying, restraint, and seclusion incidents. For the purposes of this chapter, the students with disabilities under the Individuals with Disabilities Act (IDEA) and Section 504 of the Rehabilitation Act, who represented 14% in 2015-2016 and 16% in 2017-2018 of overall student enrollment will be examined as their incidents are disproportionately higher than their peers. Students with disabilities (IDEA) represented 28% of students referred to law enforcement or school related arrest, 26% of students who had out-of-school suspension, 24% of students who were expelled, 25% of the students disciplined for bullying and harassment, and 51% of those students who were harassed or bullied. Alarmingly, students with disabilities (IDEA) represent 71% of the students who were restrained in 2015-2016 and 80% in 2017-2018 and represented 66% of the students who were placed in seclusion in 2015-2016 and 77% in 2017-2018 (US Department of Education, Office of Civil Rights, 2018; US Department of Education, Office of Civil Rights, 2020).

These behaviors and practices impact academic performance causing students to often drop out of school, display delinquent and abusive behavior, and violate the law putting them at a higher risk for entering the criminal justice system and being incarcerated (Cramer et al., 2014). Specifically, the dropout rate for students with disabilities is 18% which is 3 times greater than their peers (National Center for Education Statistics, 2020).

Treatment and Prevention of Violence in Schools

In the past decade, schools have implemented numerous school-wide preventive efforts to reduce violence. These have included positive discipline approaches, social skills training, creating emotionally and physically safe learning environments, community-based mentoring programs, peer tutoring, parent training, and training for school personnel on specialized instructional methods and techniques including additional school psychological services.

Academic Intervention

The visible co-occurrence between academic failure and behavior difficulties is undeniable. Researchers have suggested that evidence-based interventions targeting academic deficits should be implemented (Scott et.al., 2001; Witt et.al., 2004). Bowman-Perrott et.al. (2014) meta-analyzed 24 studies which examined the benefits of peer tutoring on social skills, behavior, and academics. Improvements in social skills and the reduction of disruptive behaviors was greater than academic engagement. To further the analysis of research on the effects of academic intervention modifications on student behavior, Warmbold-Brann et.al. (2017) reviewed over 32 studies. The interventions to impact academic skills included instruction in reading, math, and writing, modifying task difficulty, and performance-based feedback. When the interventions were delivered 1-on-1 the greatest impact on behavior was reported. Modification in task difficulty and changes in instruction were linked to a moderate decrease in disruptive behavior.

Maguin and Loeber (1996), meta-analyzed academic and behavior research and identified three compelling relationships. First, poor academic performance correlates with delinquency and high academic performance extinguishes delinquent behaviors. Second, there is a reduction in delinquency when interventions improve academic performance. Finally, cognitive deficits and inattentiveness are significantly associated with poor academic performance and delinquency.

Individualized Education Plan (IEP)

Students with disabilities have an Individualized Education Plan (IEP) which provides academic intervention, remediation of subject content, accommodations, strategies, modifications, and specialized therapies. However, these interventions rarely address the underlying cognitive deficits in processing, working memory, executive functioning, fluid reasoning, and attention. The author suggests that to prevent and decrease school violence in students with learning disabilities, schools should include a cognitive training curriculum. Improving cognitive skills will impact behavior and academic performance. Cognitive training can empower victims of school violence by developing the cognitive abilities that will equip them in navigating possible encounters with bullies and other perpetrators at the elementary, secondary, and college level. Cramer et al. (2014), suggested that academic success would also decrease the dropout rate which would, in turn, decrease the incarceration rate.

Disability Categories

The US Department of Education identified 13 disability categories for students receiving special education services through an Individualized Education Plan (IEP) or 504 Plan. Some 33% of students are diagnosed with a specific learning disorder (SLD), 19% communication disorder/speech or language impairments, 15% other health impairments which includes ADHD, 11% autism, 7% developmental delay, 6% intellectual disability, and 5% emotional disturbance. Students with multiple disabilities, hearing impairments, traumatic brain injuries, visual impairments, orthopedic impairments, and deaf/blindness each account for 2% or less of learners served under IDEA (NCES, 2020).

According to the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (*DSM*-5), many of these categories are neurodevelopmental learning disorders (NLD) which are characterized by developmental deficits that produce impairments of cognitive, personal, social, academic, or occupational functioning. The range of developmental deficits varies from those of average to above average intelligence with very specific limitations of learning or control of executive functions to global impairments of social skills or intelligence (American Psychiatric Association (APA), 2013). For the purposes of this chapter, the five most prevalent NLDs will be described by diagnostic criteria, common interventions, and cognitive deficits as shown in Table 1.

Table 1. **Learning Disabilities, Interventions, and Cognitive Deficits**

Learning Disabilities & Diagnostic Criteria	Interventions	Cognitive Deficits
Attention Deficit Hyperactivity Disorder (ADHD)neurodevelopmental disorder defined by	Behavior therapy and classroom strategies,	The primary cognitive impairments associated with ADHD are deficits in executive functioning, in particular behavioral inhibition, which involves suppressing a prepotent (automatic) or irrelevant

inappropriate levels of inattentive and/or hyperactive/impulsive behaviors that persist across more than one environment. ADHD is also associated with reduced school performance, social isolation, conduct disorder in adolescence, and increased risk for incarceration (APA, 2013).	modifications, accommodations	response (APA,2013). Individuals with ADHD typically perform below the average range in measures of verbal working memory, visuospatial short-term memory, and working memory. (Alloway et al., 2010a; Holmes et al., 2014; Holmes et al, 2009).
Autism Spectrum Disorder (ASD)was revised in the *DSM*-5. There was a spectrum of clinical profiles associated with this diagnosis ranging from autism, Asperger syndrome, and pervasive developmental disorder not otherwise specified (PDD-NOS) which are now integrated into the broad category of ASD (Reichenbe, 2014).	Interventions are based on the severity of the disorder. Speech and occupational therapy, behavior therapy, academic remediation, visual checklist, rules, and schedule are recommended. (Meltzer 2007)	General ability (measured by IQ tests) plays an important role in determining where individuals fall in this spectrum. There is a lack of social and communication skills as well as planning and organization skills which negatively impact learning. Students with ASD perform within age-expected levels for visuospatial, short-term, and working memory. However, they fall below the average range in measures of verbal short-term memory and working memory. This profile is consistent with the idea that verbal memory may be linked to deficits in communication (Belleville et al., 2006).
Intellectual Disability includes deficits in intellectual and adaptive functioning in conceptual, social, and practical domains. There are four levels of severity which include mild, moderate, severe, and profound. An IQ score of 65–75 (70 + or – 5) is the criterion for the diagnosis and further assessments by a clinician are needed to determine the severity level (APA, 2013).	Depending on the severity, behavior therapy, speech therapy, occupational therapy, life skills, academic modifications	Cognitive challenges are present in visual and auditory processing, working memory, comprehension, fluid reasoning, abstract thinking, executive functioning, and visual spatial reasoning skills. (APA,2013).
Communication Disorders include specific language impairment (SLI) also known as developmental language disorder, language delay, or developmental dysphasia. It is more prevalent in boys and has disproportionate difficulty in learning language despite	Speech therapy	SLI children typically have below-average performance in tests of verbal short-term memory and working memory (Archibald et al., 2006). Their visuospatial memory skills are not impaired, and performance is at the same levels as their peers in tests of both visuospatial, short-term memory and visuospatial working memory. This suggests that the difficulty that SLI children have in processing and

having normal hearing, normal intelligence, and no known neurological or emotional impairment (APA,2013).		storing information is specific to the verbal domain (Alloway Working Memory Assessment,2011a).
Specific Learning Disorder (SLD)combines the diagnosis of dyslexia or reading disorder, dyscalculia or mathematics disorder, written expression disorder, and learning disorder not otherwise specified. These students have normal levels of academic functioning. (APA,2013).	Remediation of academic skills.	There are also functional negative consequences for students with an SLD including higher rates of high school dropout, lower academic achievement, and poor overall mental health (APA,2013).
Dyslexia is a specific learning disability characterized by unexpected difficulties in accurate and/or fluent word recognition, decoding, and spelling (APA, 2013)	Remediation of reading skills. Some schools may implement a specialized reading curriculum and teach in small group or individual setting.	Dyslexia: Auditory processing, visual processing, and comprehension challenges may be present. (APA,2013). There are verbal working-memory impairments, but relative strengths in visuospatial working memory. Verbal working memory deficits impact reading ability as reading requires considerable working memory "space" to keep all the relevant speech sounds and concepts in mind. This process can exceed the capacity of the dyslexic individual and ultimately result in frustration when they encounter new vocabulary words or challenging texts (Alloway Working Memory Assessment,2011a).
Dyscalculia, or mathematics disorder, is where students struggle to learn or understand mathematics. An estimated 5 to 8 percent of children are dyscalculia with an equal representation of boys and girls affected. Students with dyscalculia find it difficult to decipher math symbols (e.g. +, -), understand counting principles ("two" stands for 2, for instance), and solve arithmetic problems. (Gerstein, 2005)	Remediation of math skills. Some schools may implement a specialized math curriculum and teach in small group or individual settings.	Struggle with telling time and recognizing patterns. Poor verbal working memory is usually only linked to dyscalculia in younger children (Gersten, 2005). Once they reach adolescence, verbal working memory is no longer significantly linked to mathematical skills (Reuhkala, 2005). Visuospatial, working-memory problems are linked to dyscalculia as it supports number representation, such as place value and alignment in columns in counting and arithmetic tasks (D'Amico & Guarnera, 2005). Poor working memory is thought to be one explanation for dyscalculia, because it limits the ability to remember mathematical rules, from basic concepts like counting in ascending and descending order to more complicated algebraic functions (Alloway & Passolunghi,2011; Peng et al., 2016, Raghubar et al.,2010).
Dysgraphia is characterized by difficulties with written	Remediation of writing skills and	Struggles in working memory and executive functioning.

expression including spelling, grammar and punctuation accuracy, and clarity or organization of written expression	occupational therapy may also be used.	

Cognitive Skills Impact on Academics and Behavior

Educators and psychologists agree that cognitive abilities control and regulate behavior, attention, and impact academic success. Cognitive skills equip students to learn complex tasks, to perform mental math problems, to ignore distractions, to follow multiple step directions, and to plan and think strategically. Specifically, executive functions have received a great deal of interest and research over the last decade (Chen et al., 2010; Diamond, 2016; von Bastian & Oberauer, 2013). There are three components of executive functions: inhibitory control, working memory, and cognitive flexibility. *Inhibitory control* allows the learner to think before acting or speaking and give a thoughtful response. Deficient inhibitory control can lead to impulsivity and making poor decisions which may result in illegal or destructive acts (Moffitt et al., 2011; Diamond 2013).

Working memory has been defined as the ability to hold onto two or more pieces of information in your mind while performing a mental operation (Camos, 2008). Efficient working memory allows learners to listen and take notes, remember the teacher's question, steps to a math problem, and what they read, as well as follow the classroom discussion. Deficient working memory impacts reading and spelling as the learner is unable to hold on to letters or visualize the story they are reading (Alloway & Passolunghi, 2011; Carretti et al., 2009, Peng et al., 2016).

Cognitive flexibility refers to altering your views as situations change. It is also necessary to consider other creative options when problem solving (Diamond, 2013). Research has found reliable correlations between executive functioning abilities to fluid reasoning, intelligence, comprehension, language, reading, and mathematics (Carretti et al 2009; Jaeggi, 2008; Alloway, 2011b). Executive functioning skills are a stronger indicator of a learner's academic and personal potential than an IQ test (Diamond 2013; Alloway & Alloway, 2014). Despite the research demonstrating this correlation, cognitive training in executive functioning skills is not explicitly taught in schools (Meltzer, 2007). Academic intervention continues to be the focus for students with deficient cognitive functions and learning disabilities.

Cognitive Plasticity

According to Strobach and Karbach (2021) and Novick et al (2020), the discoveries in neuroscience confirming the cognitive and neural plasticity of the brain to change throughout one's lifetime have ignited research in cognitive training. Specifically, there has been a focus on computerized brain training programs targeting working memory and executive functioning training. While the research has shown some near transfer effects such as being more proficient on the trained task, far transfer effects to non-trained tasks and generalization to academic abilities remains elusive with computer-based programs (Melby-Lervag & Hulme, 2014).

An alternative approach, absent in the current literature on cognitive training, involves the use of a human mediator. Over fifty years ago, Reuven Feuerstein (1921-2014), a clinical and cognitive psychologist, theorized that intelligence was changeable and modifiable regardless of age, genetics, neurodevelopmental conditions, and developmental disabilities with a human mediator even if the condition is generally considered irrevocable and irreparable (Feuerstein et al., 2010). Feuerstein's theory is known as Structural Cognitive Modifiability (SCM). The Feuerstein Institute has conducted research for the last five decades that confirms cognitive abilities can be modified with a cognitive training instrument, Feuerstein Instrumental Enrichment (FIE) using mediated learning (Tan & Seng, 2008).

Mediation Learning Experience and Cognitive Training Research

Feuerstein believed a human mediator is essential to take the learner beyond the natural limitations to reach his or her full cognitive potential and generate new cognitive structures. Higher order cognitive skills and executive functions are developed through this experience. The mediated learning experience (MLE) is an interaction between the learner and the mediator who possesses knowledge and intentionally conveys a particular skill or meaning. The learner is then encouraged to relate the meaning to another experience or thought. Meaningful human interaction with a mediator also impacts social and emotional development (Feuerstein et al., 2010; Feuerstein et al., 2015).

FIE can be implemented in a classroom, as a therapeutic intervention in a small group, or on an individualized basis. Studies have been conducted in learners with attention deficit disorders (Kaplan & Kreiger, 1990; Roth & Szamoskozi, 2001), autism (Martin, 2010; Gross & Stevens, 2005), and specific learning disabilities (Brainin, 1982; Sanches, 1994).

Another study by Kozulin et al. (2010) was conducted with 104 learners from Canada, Belgium, Italy, and Israel who had neurodevelopmental disabilities, cerebral palsy, genetically based intellectual impairments, autism, or ADHD. The FIE Basic program that is designed for young learners was used over thirty to forty-five weeks. The intervention emphasizes systematic perception, self-regulation, conceptual vocabulary, planning, decoding emotions, and social relationships that are transferred to principles in daily life. The research subjects showed statistically significant improvements in the WISC-R subtests of similarities, picture completion, and picture arrangement, as well as on Raven's Colored Matrices. Bohács (2014) also studied learners from two to fourteen years of age with mild to moderate intellectual developmental disorders, including genetic syndromes, cerebral paresis, ADHD, and autism. Significant changes in cognitive development and growth in domains necessary for school readiness were demonstrated as well as gains in general intelligence on the Raven's Colored Matrix.

Cognitive Functions

Feuerstein looked beyond academic and psychological testing as he saw these as static assessments. He did not focus on academic skills or even define cognitive skills in terms of executive functioning, visual spatial reasoning, fluid reasoning, processing, working memory, or verbal comprehension. Rather, he examined the cognitive function underlying intelligence regarding what is going on in the learner's mind (Feuerstein et al., 2006).

Cognitive functions are defined by Feuerstein as "thinking abilities" that can be taught, learned, and developed. Hence, they are the prerequisites of thinking and learning. There are three phases of cognitive functions: input, elaboration, and output. This model can be used by trained teachers and parents to better understand and help the child who is experiencing learning difficulties. Teachers can differentiate errors due to a lack of knowledge or from a deficient cognitive function (Feuerstein et al., 2006; Feuerstein et al., 2015). For example, if a child is struggling with a concept, it may be due to underdeveloped cognitive functions, such as imprecise data gathering at the input phase or poor communication skills at the output phase. The following list outlined in Table 2, as defined by

Feuerstein, identifies, and describes the deficient cognitive functions (Feuerstein et al., 2006).

Table 2. Deficient Cognitive Functions

Input – Taking in Information	Elaboration – Working on the Problem	Output – Communicating a Response
Deficient: Blurred and sweeping perception of essential information occurs. The learner struggles to gather the correct information.	Deficient: Lack of ability to recognize the existence and definition of an actual problem.	Deficient: Egocentric communication modalities are present. It is difficult for the learner to relate to others and to see things from another's perspective.
Deficient: Difficulty in temporal and spatial orientation occurs. The learner lacks the ability to organize information realistically and to describe events in terms of where and when they occur.	Deficient: Inability to select relevant vs. non-relevant cues or data in defining a problem is present. Efficient: The learner can recognize what is relevant to the problem and what can be ignored.	Deficient: Lack of ability to repeat an attempt after a failure or blocking is present. Efficient: The learner can persevere and overcome blocking.
Deficient: The learner is lacking skills in precision and accuracy.	Deficient: Difficulty in comparative behavior is present. This may be due to slow processing and inability to make comparisons between two or more things.	Deficient: Difficulty in projecting virtual relationships.
Deficient: Inability to identify an object when there is a change in size, shape, quantity, or orientation, though it is the same object.	Deficient: A narrow mental field is present. There is an inability to combine, group, and coordinate information.	Deficient: Use of trial-and-error responses, which leads to failure to learn from previous attempts, is present.

Deficient: Lack of capacity for considering two or more sources of information at once is present. This is reflected in dealing with data in a piecemeal fashion rather than as a unit of organized facts.	Deficient: The projection of virtual relationships is impaired. The ability to perceive the relationship between events is difficult.	Deficient: Lack of, or impaired tools for communicating adequately elaborated responses.
Deficient: Impulsive and unplanned exploratory behavior is present.	Deficient: The absence of or need for logical evidence, inferential-hypothetical thinking, and hypothesis development occurs.	Deficient: Lack of self-control, impulsive, or acting-out behavior is demonstrated.
	Deficient: Inability to visualize and create mental images is present.	Deficient Lack of, or impaired, need for precision and accuracy in communicating one's responses.
	Deficient Difficulty defining goals, planning behavior, and taking steps in problem solving occurs.	Deficient Lack of self-control, impulsive, or acting-out behavior is demonstrated.

Feuerstein sought to identify and correct these deficits to enable students to reach their full cognitive potential, as well as to increase their internal motivation, personal confidence, academics, and behavior. By using mediated learning and a cognitive training program, these deficient functions can be corrected, formed, and modified in significant ways (Feuerstein et al., 2010).

Equipping Minds Cognitive Development Curriculum

The *Equipping Minds Cognitive Development Curriculum* (*EMCDC)* was developed by the author and is based on Feuerstein's theory of Structural Cognitive Modifiability (SCM), Mediated Learning Experience (MLE), and affirms that cognitive skills can be developed in the classroom or therapeutic setting in person or online, through a human mediator. The cognitive training program is designed to help any individual wanting to strengthen their ability to learn; from learners 3-90 years of age and from gifted learners to those with neurodevelopmental disorders including specific learning disorder, attention deficit hyperactivity disorder, Down syndrome, post-concussion syndrome, traumatic brain injury, fetal alcohol syndrome, communication and language disorders, auditory processing disorder, visual processing disorder, intellectual and developmental disorder, and memory challenges. *EMCDC* also employs a holistic approach to cognitive development that includes primitive reflex exercises and sensory-motor developmental exercises in addition to the cognitive training exercises.

Reflex integration exercises

Primitive reflex exercises are done 5-7 days a week for 6-12 weeks and take 15 minutes a day using the *Maintaining Brains Everyday* (Johnson, 2015). Primitive reflexes act as a foundation for more complex muscle movements and later cognitive tasks. The reflexes are integrated in a sequential fashion in utero and during the first year of life. The lack of integration can interfere with processing and affect learning, movement, and attention impacting cognitive and academic skills. The visual motor system is intimately involved in the transition from primitive reflexes to control of movement patterns. By replicating the stages of development, the neural pathways can be strengthened, allowing for treatment to be successful (Goddard-Blythe, 2005a; Goddard-Blythe, 2005b).

Sensory-motor development

Sensory-motor development includes visual processing and auditory processing. Visual processing includes visual tracking, visual localization and fixation, visual coordination, and visual cognitive problem-solving skills. Students with poor visual motor development have a hard time finding the words for objects they are viewing. Alternatively, if they are asked to get an object, they might look right at it and say they cannot find it. Although they are seeing the object, their brains are not efficiently processing the fact that they are seeing it (Ayers, 2005). *EMCDC* includes numerous visual processing exercises.

Effective auditory processing is foundational for speech, phonemic discrimination, working memory, language, and learning. Auditory processing exercises benefit learners with reading, language, and fluency disorders by providing auditory feedback to help the students detect their errors (articulation, phonological processing), help to regulate vocal intensity, self-monitor their reading fluency and increasing their auditory memory. A student may hear what is being said, but the brain does not process it fast enough or accurately enough. The result is that the student misunderstands what was said or it takes a long time to process what was said (Doidge, 2015; Joundry & Joundry, 2009; Joundry, 2005). Throughout the *EMCDC*, auditory processing exercises are implemented.

Some learners with auditory processing disorders, ADHD, and sensory disorders benefit from listening to sound therapy to rehabilitate the auditory system. Sound therapy was developed by Alfred Tomatis, MD, to strengthen the auditory system. He discovered that playing filtered classical music directly into the ear increased learning ability, brain function, coordination, and emotional health (Joundry, 2009). Students wear sound therapy while doing the *EMCDC* cognitive exercises.

Cognitive training exercises

The cognitive training and developmental exercises set aside academic content to correct and strengthen deficient cognitive functions. Learners participate in interactive games and paper-and-marker activities which are organized in a progressive and challenging manner to strengthen cognitive functions as outlined by Feuerstein. These activities also strengthen the cognitive skills of working memory, long term memory, processing speed, visual processing, auditory processing, executive functioning, attention, language, fluid reasoning, visual-spatial reasoning, and comprehension.

Playing games is a powerful therapeutic tool for developing self-regulation, awareness of others, and cognitive functions (Porges, S. & Dana, D., 2018; Purvis 2007). A trained mediator encourages the learner to "think aloud" and verbalize what they are processing and thinking. Verbalization increases language processing. The mediator and learner also take turns when playing the numerous sorting, memory, and strategic card games and exercises which strengthen cognitive functions, social and emotional skills, hence impacting academic skills, behavior, and relationships.

The structure for mediating within the curriculum is specified in the *EMCDC* and summarized in Table 3. The mediator follows the *EMCDC* full program as the intervention is typically 60 hours over

24 weeks (Brown,2018a). Brown combines the work of Feuerstein with Aristotle's *Ten Categories of Being* to guide the mediator through the *EMCDC* exercises and games (Brown 2018a). While the implementation is the same for all learners, individualization will occur based upon the learner's progression. By using mediation, these cognitive functions can be corrected, formed, and modified in significant ways enabling students to reach their full cognitive and academic potential (Mentis, 2009).

Aside from the academic benefits of the *Ten Categories of Being* and mediated learning questions, schools are reporting significant benefits in social and emotional skills. It is essential for students to maintain positive relationships and navigate the stress and anxiety of learning. A student may feel threatened or embarrassed when conflict arises between a peer or teacher or when they are experiencing academic frustration leading to poor decisions as seen in negative reactions and violent behaviors. Schools report that the *EMCDC* has been beneficial in laying the foundation for social and emotional learning skills as it fosters a safe place to practice the basic skills needed to analyze and respond to relationships. Through the daily practices, high level analyzing is occurring as they start to develop reasoning skills which easily transfer to relationships. Hence, when schools are implementing a formal social and emotional learning program which seeks to teach students to manage emotions, have empathy, solve problems, make responsible decisions and maintain healthy relationships, the student's participation has been significantly improved since doing the *EMCDC.*

Table 3. Equipping Minds Mediation Questions Based on Feuerstein's Cognitive Functions and Aristotle's Ten Categories of Being

Collecting	Processing	Expressing
● What or who do you see, hear, feel, taste, touch, and smell? ● What can you visualize or imagine in your mind? ● What do you see yourself doing? ● What is the name of what you see or are thinking? ● Where are you starting?	● What am I to do? ● Problem, what problem? ● What do you need to figure out? ● What is relevant to the problem? ● What is needed, and what can be ignored/omitted? ● What is similar? ● What characteristics are different?	● What does the other person believe and why? ● How does the other person feel? ● Can you imagine how you would feel in their position? ● How would the other person want to be viewed and treated? ● Have you thought through what you want to say or write?

• Do you have the correct materials? • What parts do you need, and what order will you need to follow to make the finished product? • What do you know to be true, or what is constant and does not change? • What is to your right? What is to my right? • If you are facing in this direction, what is to your right? Left? Front? Back? East? West? North? South? Northwest? Southeast? • When do you see this happening – past, present, future? • How long did the event occur? In what order did it happen?	• Consider: number, color, shape, size, direction, position, and feeling • What different categories do you see? • How are these related to each other? • Ask: What is your plan? What are the steps you will follow and the reasons? • Avoid trial and error! Have a plan. • Does this make sense? • If this is true, then what else must be true? • Are there different possibilities? • How can you see if this is true?	• Are your words relevant to the situation? • Is your language clear to the audience? • Do you need to take a break and attempt later or tomorrow?

(Source: Brown, 2018b)

Stroop Effect and N-Back Training

In developing the *EMCDC*, Brown reviewed the research conducted to increase working memory and executive functions. One of the first cognitive training exercises was developed by psychologist John Ridley Stroop in the 1930s. The Stroop test asks learners to view a list of words that are printed in a different color than the actual word (Stroop, 1935). EMCDC integrates the original Stroop exercise with colored words and incorporates additional elements alternating the color, word, number, animal, and symbol associated with the color or word. Dr. Eric Chudler also created three variations of the Stroop Effect with animals, directions, and numbers which are included in the *EMCDC* seen in Table 5 (Chudler, 2012).

In 1958, a single *n*-back task emerged to train working memory and executive functions followed by a dual *n*-back task (Jaeggi et al., 2003). Some studies have reported near transfer effects but failed to demonstrate far transfer effects confirming that generalization remains elusive (Jaeggi, 2008; Jaeggi, 2014). Brown developed an adaptive *n*-back with nine tasks or the "Brown Six-Nine *N*-Back" in which learners were asked to associate animals, letters, vowels, numbers, presidents, and sounds with symbols and colors as well as identify directions of left, right, up, and down. To Brown's knowledge, there has not been a nine *n*-back task in which the learner hears auditory instructions, uses their hands to write or place a cube while holding a pattern for nine categories, processing the information visually, and verbalizing what they are doing. There are over 60 possible items the learner is retrieving from their long-term memory while using their working memory to hold onto multiple pieces of information from regions of the brain which contain letters (A-I), vowels (a,e,i,o,u), sounds, numbers, pictures or images of animals and presidents, symbols, directions, and colors. If the learners succeeded at a particular level of *n*, the task was made incrementally more difficult by increasing the size of *n* to nine as seen in Tables 4, 5, 6, 7, and 8, and Figure 1 which are included in *EMCDC*.

Multi-Component, Multi-Domain, and Multi-task Training

In using all nine variables of *n, EMCDC* is a multi-task, multi-component, and multi-domain cognitive training program with a mediator providing social engagement. Multi-task components include visually scanning the information, writing numbers, letters, and symbols with a dry erase marker, placing the corresponding-colored cubes, and verbalizing what they are doing when holding onto a sequence of 2-9 categories. *EMCDC* also uses various card games which train multiple cognitive skills. These multi-component elements include focused attention interfacing with long term memory, visual and auditory processing, working memory, and reasoning. By working these cognitive functions in multi-domains through the reflex exercises, sound therapy, and the cognitive games which require eye-hand coordination with verbalization, there is an increase in functional connectivity among various regions of the brain (Kuo et al., 2018; Cao et.al, 2016).

Table 4. Brown Six-Nine *N*-Back Equipping Minds Cognitive Development Curriculum

Cognitive Functions Targeted	Exercise	Description
		Mediator states 1-2 directions ex: "I see you putting a circle around the one…" What do you see yourself doing? Learner replies, "I see myself putting a circle around the one" and performs the action. Use a page protector and dry erase marker.
Visual processing, auditory processing, working memory, visual motor coordination, receptive and expressive language, visual spatial reasoning, abstract thinking, refraining impulsivity,	Stroop Animals	Circle around bear, box around snake, X on fish, triangle around cat, line under elephant, line above turtle and continue for 20 directions. *N*-Back- Read Set 2 and say the animal, word, symbol, letter of animal, classification Recreate the directions on a blank grid.

Projection of relationships, numerical awareness, comparisons, visualization, expressive language, long term memory, and working memory	Presidents "Yo Millard Fillmore" book	Describe the pictures of the 46 US presidents stating what and who, quantities, qualities, time, where, clothing, feelings, action, positions, and relationships.
Working memory, visual and auditory processing, long term memory, attention, expressive and receptive language, abstract thinking, visual motor coordination, refraining impulsivity, logical thinking	Numbers 1-5	Use a page protector and dry erase marker. First, place symbols and then cubes with corresponding numbers. Circle/green cube on 1, x / blue cube on 2, box /red cube on 3, yellow/underline 4, black/ line above 5. Remove page protector and read symbols alternating saying the number, color, animal, vowel, vowel sound, symbol, president, letter- an 8 *n* back.
Working memory, visual and auditory processing, long term memory, attention, expressive and receptive language, abstract thinking, visual motor coordination, refraining impulsivity, logic thinking	Number 1-9	Use a page protector and dry erase marker. First, place symbols and then cubes with corresponding numbers. Circle/green cube on 1, x/ blue cube on 2, box /red cube on 3, yellow / underline 4, black/ line above 5. Orange/slash on 6, brown / (on 7, white / ( ) on 8, and purple / line in the middle of nine. Remove page protector and read symbols back by alternating saying the number, color, animal, letter, letter sound, president, symbol
Working memory, visual and auditory processing, long term memory, attention, expressive and receptive language, abstract thinking, phonemic processing, refraining impulsivity, logical thinking, spontaneous comparison,	Vowels a-e	First, place symbols and then cubes with corresponding letters. Circle/green cube on a, x/ blue cube on e, box /red cube on i, yellow / underline o, black / line above u. Remove page protector and read symbols back by alternating saying the vowel, sound, color, number, animal, president- a 7 n back. Also do the 7 n back with the cubes covering the letters.
Working memory, visual and auditory processing, long term memory, attention, expressive and receptive language, abstract thinking, phonemic processing, refraining impulsivity, logical thinking, spontaneous comparison,	Letters A-I	First, place symbols and then cubes with corresponding letters. Circle/green cube on A, x/ blue cube on B, box/red cube on C, yellow/ underline D, black/line above E. Orange/slash on F, brown/(on G, white/( ) on H, and purple/ line in the middle of I. Remove page protector and read symbols back by alternating saying the letter, sound, color, number, animal, president, symbol a 7 n back. Also do the 7 n back with the cubes covering the letters.
Spatial concepts of left, right, up, down, Inductive thinking, inductions of rules, seriation, working memory,	Colored Arrows *5 colors & 9 colors	Say the direction of the arrow, then the color, then alternate color, direction. Add the corresponding number and say number, color, direction. Add the corresponding animal and say number, color, animal,

long term memory, auditory and visual processing, abstract thinking, Systematic approach to new information and object, refraining impulsivity, logical thinking, spontaneous comparison		direction. Add the corresponding vowel and say the number, color, animal, vowel, vowel sound, and direction. Add the president sequentially and say the number, color, animal, vowel, vowel sound, president, letter, symbol, and direction. 9 n-back

(Source: Brown, 2018b)

Stroop Animals
Circle the Bear
Box the Snake
X the Fish
Underline the Elephant
Line above the Turtle

Table 5. Animals.

Basic US Presidents	
1.	Washington green and circle
2.	Adams blue and X
3.	Jefferson red and box
4.	Madison yellow and underline
5.	Monroe black and line above
Advanced US Presidents are said sequentially for n–back	
1.	Washington
2.	Adams
3.	Jefferson
4.	Madison
5.	Monroe
6.	John Quincy Adams
7.	Jackson
8.	Van Buren
9.	Harrison
10.	Tyler
11.	Polk
12.	Taylor
13.	Fillmore
14.	Pierce

Table 6. US Presidents (Brown, 2018b)

2 1 5 4 3 circle the 1 and place a green cube
5 3 2 4 1 X the 2 and place a blue cube
3 1 4 2 5 box the 3 and place a red cube
5 4 3 1 2 line under the 4 and place a yellow cube
4 2 5 3 1 line above the 5 and place a black cube

Table 7. 1-5 Numbers (Brown, 2018b)

e a u o i circle the a and place a green cube and the sound is a short "a"
u i e o a X the e and place a blue cube and the sound is a short "e"
i a o e u box the i and place a red cube and the sound is a short "i"
u o i a e line under the o and place a yellow cube and the sound is a short "o"
o e u i a line above the u and place a black cube and the sound is a short "u"

Table 8. Vowels a, e, i, o, u (Brown, 2018b)

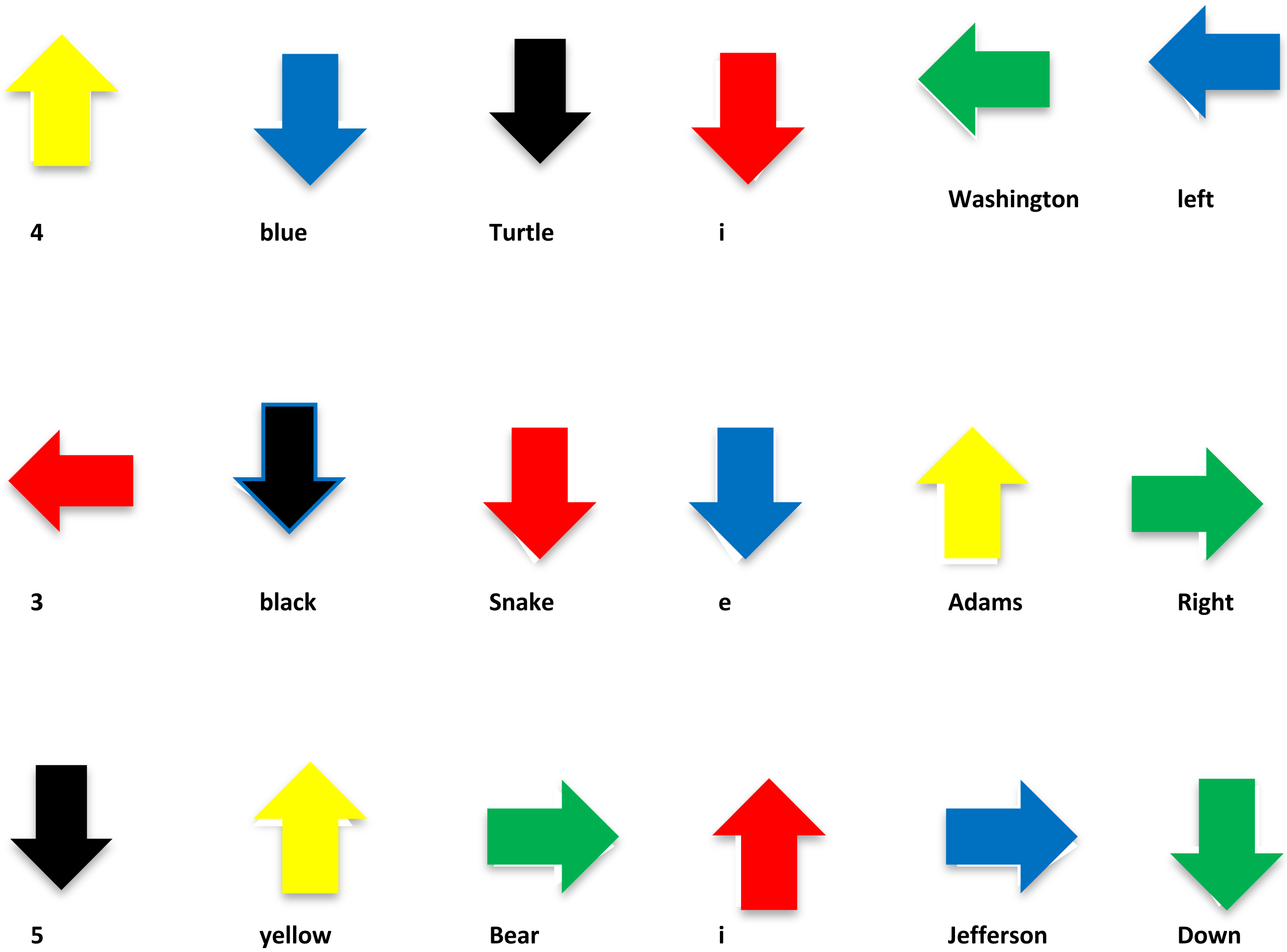

Figure 1. Brown Six N Back (Brown, 2018b)

Say the number, color, animal, vowel, president(sequentially), direction.

Using a page protector and dry erase marker, say and mark the six items. Place a point at the tip of the arrow for the direction. Remove the page protector and read the symbols: number, color, animal, letter, president (sequentially), direction (Brown, 2018b).

Cognitive Neuroscience and Education

According to cognitive neuroscientist Stanislas Dehaene (2013), learning uses symbols to process letters, sounds, colors, numbers, and images which correlates with the Brown-*n* backs relationship of symbols to numbers, colors, sounds, letters, vowels, and images of animals and presidents. The four pillars of learning identified by cognitive psychologists include: focused attention to relevant information, active engagement between the teacher and learner, feedback to overcome errors successfully which instills internal motivation by providing positive verbal encouragement, and consolidation or transfer of acquired skills and information to knowledge (Dehaene, 2013). The four pillars overlap with Feuerstein's cognitive functions, mediated learning experience, and the *EMCDC* program. The combination of these components lays the foundation for academic success in the classroom.

Implementation and Benefits of Equipping Minds

Since 2010, professional development workshops have been conducted for educators, parents, interventionists, and therapists in person, online, and through prerecorded online courses. Participants receive the Equipping Minds Cognitive Development Curriculum and Equipping Minds Student Workbook. Schools are implementing 30 minutes a day in the classroom for all students. Students who are experiencing learning challenges also use

Equipping Minds in tiered intervention for an additional 20-30 minutes a day. Small group and individual intervention are done with students with learning disabilities. Schools report the following benefits: increased reading fluency and comprehension, improved math and writing abilities, focused attention, increased participation in class and confidence, thinking before speaking and acting, improved relationships and self-regulation, and the ability to follow multi-step directions.

Specifically, students with disabilities (IDEA) have an IEP. *EMCDC* is being included in public and private school IEPs. Table 9 includes the cognitive abilities tested on psychological testing, the implications for academics, the goals for cognitive training, and the corresponding *EMCDC* exercises to implement. The author suggests using this template for all students under IDEA to target their cognitive skills which will impact academics reducing frustration in the classroom.

Table 9. Cognitive Abilities and Equipping Minds Cognitive Training Intervention

Cognitive Ability	Implications for Academics	Goals	Equipping Minds Cognitive Training Intervention
Comprehension-Knowledge (*Gc*) Verbal/Crystallized Intelligence The ability to communicate one's knowledge of word meanings, factual information, comprehension, concepts, rules, and relationships. The ability to reason using previous learned experiences, procedures, and knowledge obtained through one's life experiences, school, and work.	Highly predictive of academic success. Strong and consistent relationship to reading, writing, and math throughout school: learning vocabulary, answering factual questions, comprehending oral/written language.	*Increase comprehension, retain information, understand relationships, and reason. *Visualize, retain, and express what they hear and read.	**Exercises to increase comprehension, retain information, understand relationships, and reason**: *Follow Aristotle's ***Ten Categories*** of Being: what/who, quantities (numerical value), qualities (size, color, shape), action, time, where, relationships, feelings, position, clothing/accessories as your guide to discuss everything. Begin with a picture using the ***STARE Jr***. cards, ***Yo, Millard Filmore*** president's book. *Read short stories, Aesop's

			fables, and ask questions base on the ***Ten Categories.*** *Recall the Stroop Animal directions from memory saying forward and backwards. *Build comprehension through vocabulary exercise
Cognitive Processing Speed (*Gs*) The ability to automatically and fluently perform cognitive tasks, particularly when measured under pressure to maintain focused attention. The ability to accurately identify and quickly scan and discriminate visual information to make and implement decisions.	There is a significant impact to reading, writing, and math: completing assignments on time, processing information quickly, copying from the board, and taking timed test.	*Increase processing rate and fluency. *Increase Rapid Automatic Naming pictures, letters, numbers, colors, shapes. *Increase language processing by say what you're doing when sorting the cards and reading the charts/pages. *Increase time when saying what you're doing when reading a page of numbers, vowels, letters, colors, directions, shapes, animals. *Increase hand-eye coordination sorting	**Exercises to increase processing rate and fluency:** *Sort Blink cards, SET, or a deck of cards naming numbers, colors, and shapes/suit. *Sort Qwitch cards naming letters and numbers. *Read Animal Set 1, Direction Set 1, and Number Set 1 of Stroop Effect. *Read the colors of the arrows and then the directions. *Read Number Hunt 1-5 and 1-9 numbers.
Auditory Processing (*Ga*) The ability to perceive, analyze, manipulate, compare, discriminate, and synthesize patterns among auditory stimuli (speech sounds). The ability to employ auditory information in task performance. It includes phonological awareness, processing, sensitivity, and coding.	There is a significant relationship to reading, writing, and spelling: acquiring phonics, sequencing sounds, listening, learning a foreign language, musical skill. A weakness in phonological processing and awareness is a common factor among learners with reading challenges.	*Increase phonemic awareness. *Increase ability to retain and manipulate speech sounds.	**Exercises to increase phonemic awareness and auditory processing:** *Read the vowels and say the sounds in Vowel Hunt. Use a phonics phone when learning the sounds. Teacher should speak directly into the learner's right ear. *Read the letters and say the sounds Letter Fluency for A-H.*Read Letters (b,d,p,q,m,w) exercises to say the direction, letter name, and sound. *Sound therapy can be very beneficial for increasing auditory processing abilities.
Short-Term & Working Memory (*Gwm*) The ability to apprehend, hold, and manipulate visual and auditory information in immediate awareness while performing a mental operation on it. Requires attention, auditory and visual discrimination, and concentration. **Auditory Working Memory:** The ability to hold auditory information in immediate awareness while performing a mental operation on the information. **Visual Memory:** The ability to hold visual information in immediate awareness while performing a mental operation on the information.	There is a significant impact to reading, writing, and math: following multi-step directions, recalling sequences, memorizing information, listening, and comprehending, taking notes, remembering math steps, holding letters and sounds in place for reading and spelling.	*Recall and complete three and four step directions. *Verbalize what he is doing when alternating a sequence of three and four qualities *Recall the Stroop Animals forward and backwards *Recall numbers from memory forwards and backwards? 6-3-8-1, then 9,4,2,7,6. *Show 3 Blink cards. Turn them over and ask to recall. Then ask to recall 2 minutes later. *Verbalize a sequence of 4-9 items on the Brown *n*-back	**Exercises to increase working memory and following multi-step directions:** *When giving directions, begin with "I see you… What do you see yourself doing?" *Blink/Cards: Alternate saying the number, color, and shape/suit. *Qwitch: Alternate saying =, +, - *ALL Stroop Exercises: Sets 1 and 2. *Colored Arrows alternating number, color and direction. *Vowel and Number Hunt exercises: Begin with one direction and build on from there. *Use b, d, p, q, and other direction exercises *Brown 4-9 *n*-back sequence on Arrows, Number Hunt 1-5

			and 1-9, Vowels and Letter Fluency Auditory and Visual Working Memory *Find It, Write it, & Say it: Use any list & build on it daily. Do not progress without mastery, and don't add too much too fast. *Say 2-4-7, /2-4-7-3; and 5-1-6-9, / 5-1-6-9-2*Xtreme Memory with linking cubes, letters, numbers, and symbols *Xtreme Tic Toe *Visual and Auditory Recall *Stare Cards: Ten Categories *Presidents
Long-Term Memory (*Glr*) The ability to store information (ideas, names, concepts) in one's mind and fluently retrieve it later in the process of thinking. Retrieval should be done easily, quickly, and using association.	There is a significant relationship to reading, writing, and math, especially during basic skill acquisition of learning numbers, letters, colors, shapes, sounds, and animals. Organization and classification of information is needed to make recall possible.	*Increase the number of items the learner can recall. *Name as many animals or any category as fast as you can in 1 minute. *Learn the presidents and recall forwards and backwards *Categorize animals and other categories	**Exercises to Increase long-term memory retrieval:** *Play Make a List. Name as many animals as you can in 1 minute. Use any category in which you have information in your long-term memory and recall. *Recall and categorize the items in Make a List, Spot It cards, Stroop Animals *Finger exercises for the Palmer reflex daily. *Recall stories you have heard and pictures you have seen over a 1-month period. *Recall the President's full name, number, and picture from *Yo Millard Fillmore.*
Fluid Reasoning (*Gf*) The type of thinking an individual may use when faced with a relatively new task that cannot be performed automatically. The ability to reason, form concepts, detect underlying relationships and rules among objects to solve problems.	Significant relationship to higher level skills in reading, writing, and math; problem solving, drawing inferences, cognitive flexibility, transferring and generalizing, thinking conceptually.	*Apply problem solving strategies and procedures. *Verbalize the thought process when playing Set, Color Code, Blink, Tic Tac Toe, Perplexors, and Critical Thinking exercises.	**Exercises to increase fluid reasoning:** *Color Code *Blink Game *SET *Xtreme Tic Tac Toe *Perplexor Puzzles *Critical Thinking K-3 and 4-7 with verbalization
Visual Processing (*Gv*) The ability to perceive, analyze, and synthesize visual patterns, including the ability to store and recall visual images. **Visual Spatial Reasoning** The ability to evaluation visual details and to understand visual spatial relationships to construct geometric designs from a model.	There is a significant relationship to reading, writing, and math, especially during basic skill acquisition of learning numbers, letters, colors, shapes, sounds, and animals. Organization and classification of information is needed to make recall possible.	*Read letters, numbers, and words without skipping lines *Read letters, numbers, and words fluidly and calmly *Verbalize his thought process when playing Color Code	**Exercises to increase visual processing and visual spatial reasoning:** *Color Code *Xtreme Memory *Xtreme Tic Tac Toe *Tangrams

Case Studies with Equipping Minds

Since 2010, *EMCDC* has been implemented 1-on-1, demonstrating far transfer effects to cognitive and academic gains. Seven case studies[2] of learners with a neurodevelopmental disorder will be examined.[3] Brown utilized the following data collection techniques: clinical observations of the learners, examining and analyzing the psychological and educational documents, and interviewing the parents, the learners, and teachers. Academic and psychological testing ranged from one to six years providing significant insights into the impact cognitive training had on each learner. Six of the seven cognitive developmental therapies, i.e.., cognitive training, were conducted online. Three of the seven were international adoptions at four and five years of age. It should also be noted that English was their second language, and each had experienced trauma at a young age.

Case 1. Marie: Down Syndrome and Intellectual Disability

Marie[4] was born with a neurodevelopmental disorder: Down syndrome.

Assessment

[2] Parts of this chapter, including cases 1-6, have published previously in: Brown, C.T., & Merrick, J. (Eds.). (2018). Equipping Minds Cognitive Development [Special issue]. *Journal of Alternative Medicine Research*, 10(2), licensed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/)

[3] These case studies are a revised version of an earlier publication by Brown (2018c) shared with Merrick's permission.

[4] All names and other personal identifiers in the case studies have been changed to protect privacy and confidentiality.

Academic testing was conducted over a four-year period using the Measures of Academic Progress (MAP), Kentucky Performance Rating for Educational (KPREP), Stanford Ten National Assessment Ranking, and Student Growth Profiles.

Intervention

Equipping Minds Cognitive Development Curriculum (*EMCDC*) was done from 2011-2015. In September 2010, the author worked with Marie an hour of every school day for twelve weeks.

Results after intervention

At the end of nine weeks, the principal reported that Marie had increased 20 points in reading, 11 points in math, 16 points in science, and 17 points in language arts on the Measures of Academic Progress (MAP). The gains were unprecedented as students typically increase 3-5 points on the MAP.

Marie would continue the EMCDC cognitive developmental exercises and continue to progress academically for the next four years. Below are the results of the MAP tests after the first nine weeks and over the next four years. Figures 2-5 illustrate re-creations of the MAP test results which demonstrate significant gains in academic abilities, or far transfer effects. It should be noted that the only accommodation she received on MAP testing was extended time and having a reader for math, science, and language. She read the reading assessments herself.

Her Kentucky Performance Rating for Educational (KPREP) scores showed gains in math, reading, and writing on-demand. Marie's Kentucky Performance Rating for Educational Progress (KPREP) scores in sixth grade showed strong growth. The KPREP test is more comprehensive and has historically been difficult for Marie. In seventh grade she scored two points above the state mean in mathematics and was one point from a proficient status. The apprentice level for the seventh grade states that a student can compute a percent of a number, use ratios to solve problems, evaluate mathematical problems using order of operations with integers, solve two-step equations, evaluate algebraic expressions with two or more variables using order of operations, select and apply basic geometric formulas, identify cross sections of a 3-D object taken parallel to a base, identify an appropriate sample for a population, and compute measures of central tendency. Re-creation of her KPREP scores is illustrated on Figures 6-8.

Marie's student growth percentile (SGP) in reading was 93 percent in sixth grade and 7 percent in seventh grade. Her SCP was 63 percent in math as a sixth grader and 93 percent in seventh grade. Figure 9 illustrates a re-creation of the SCP for sixth and seventh grade. In 2015, as a seventh grader, she scored in the 39th percentile in mathematics, 36th percentile in science, and the 7th percentile in reading on the Stanford Ten National Assessment Ranking. Figure 10 illustrates a re-creation of the Stanford National Ranking.

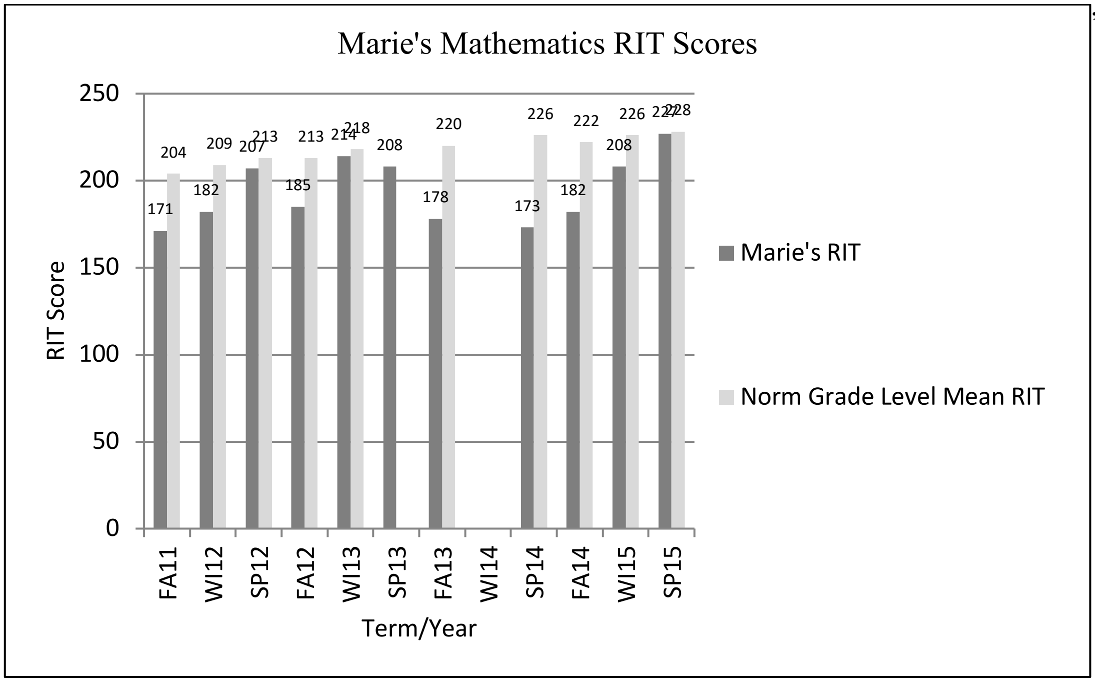

Figure 2. Marie's mathematics RIT scores

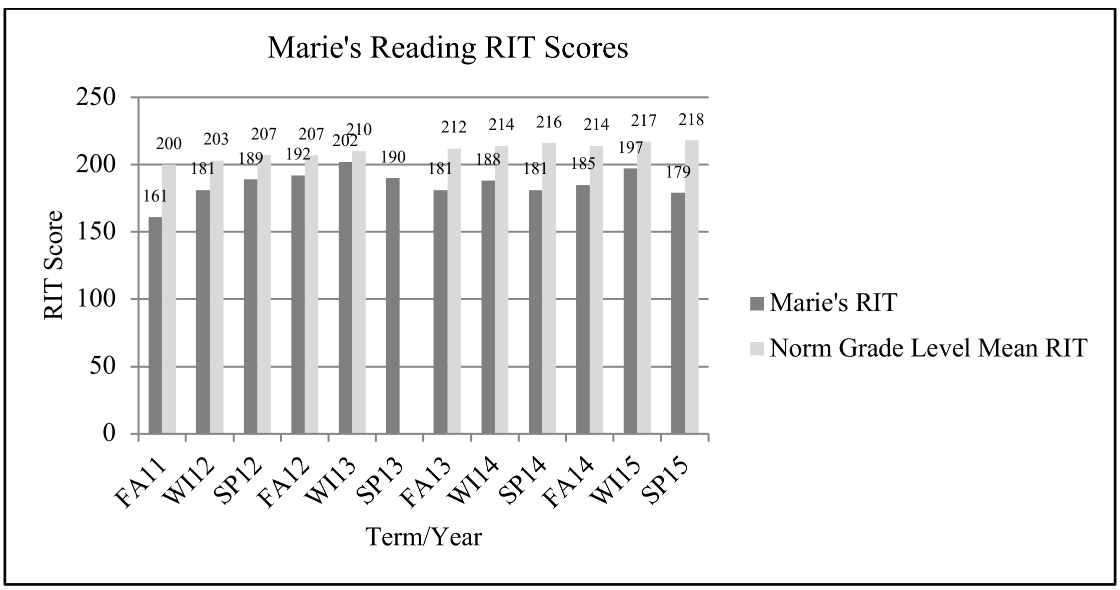

Figure 3. Marie's reading RIT scores

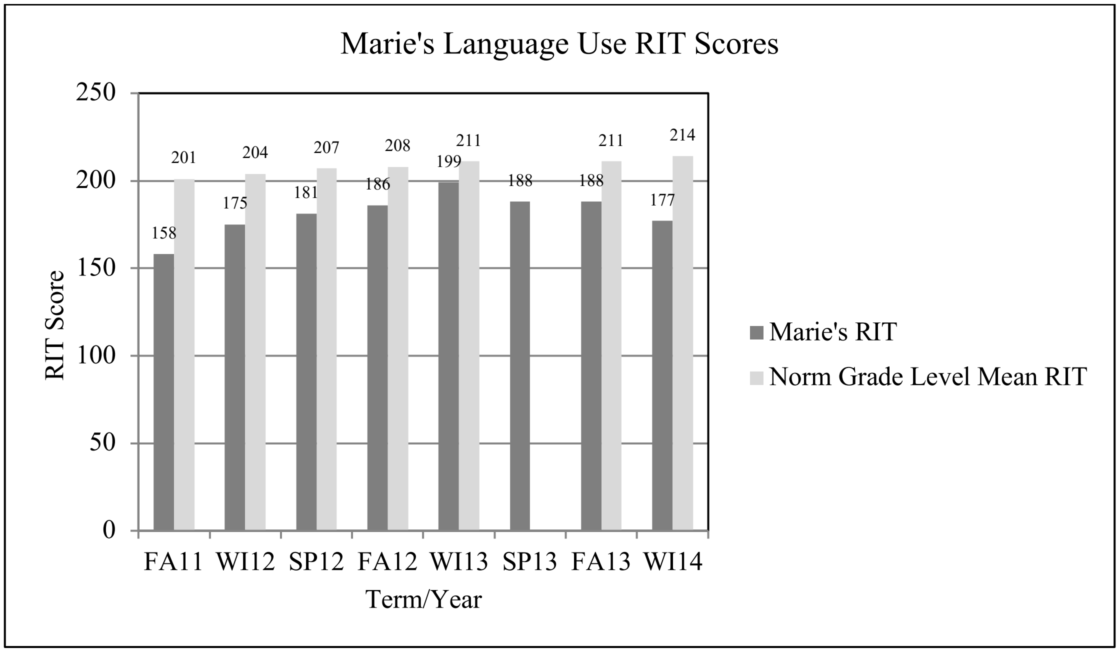

Figure 4. Marie's language RIT scores

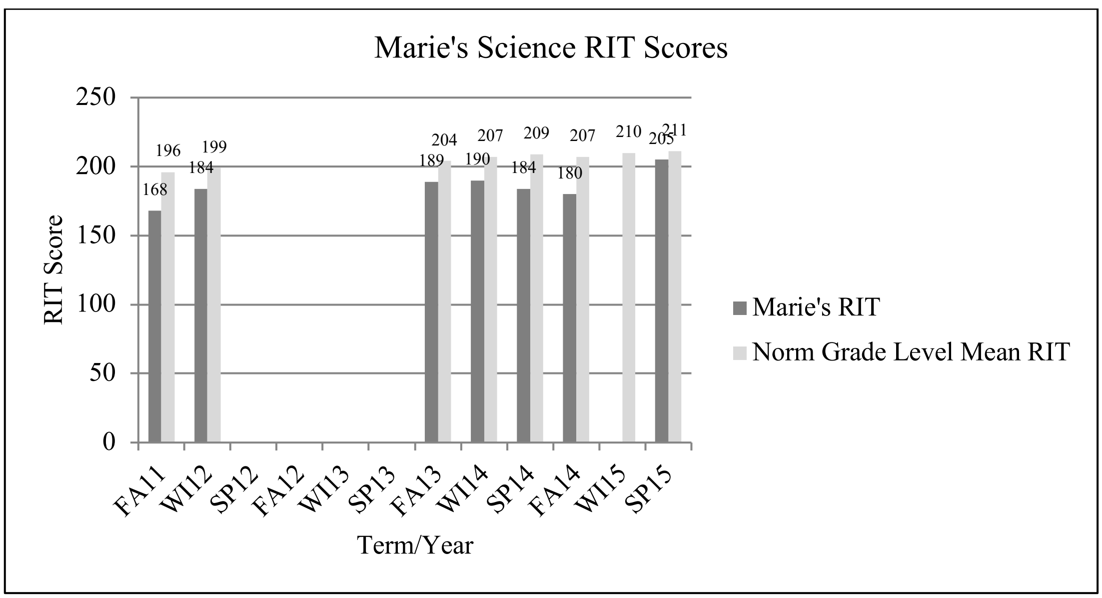

Figure 5. Marie's science RIT scores

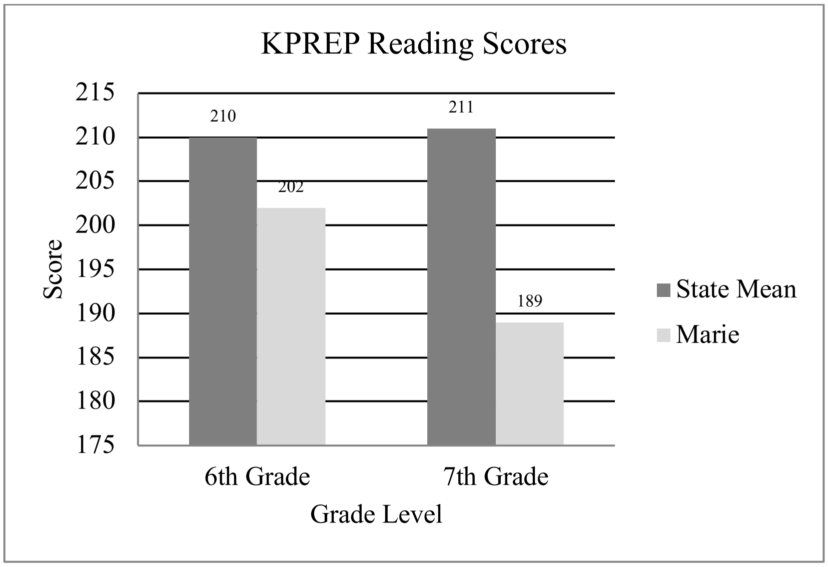

Figure 6. KPREP reading scores

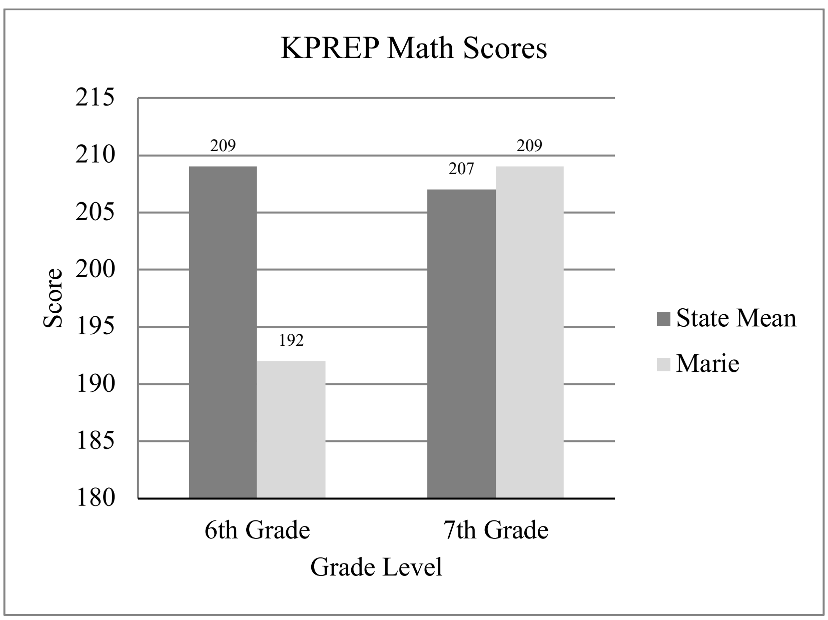

Figure 7. KPREP math scores

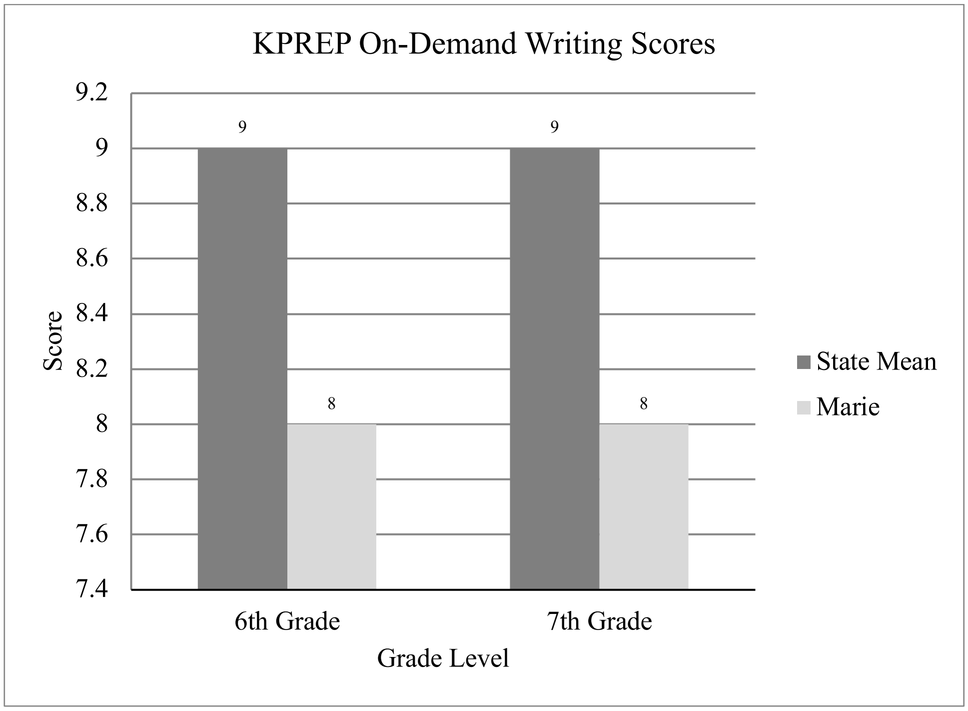

Figure 8. KPREP on-demand writing scores

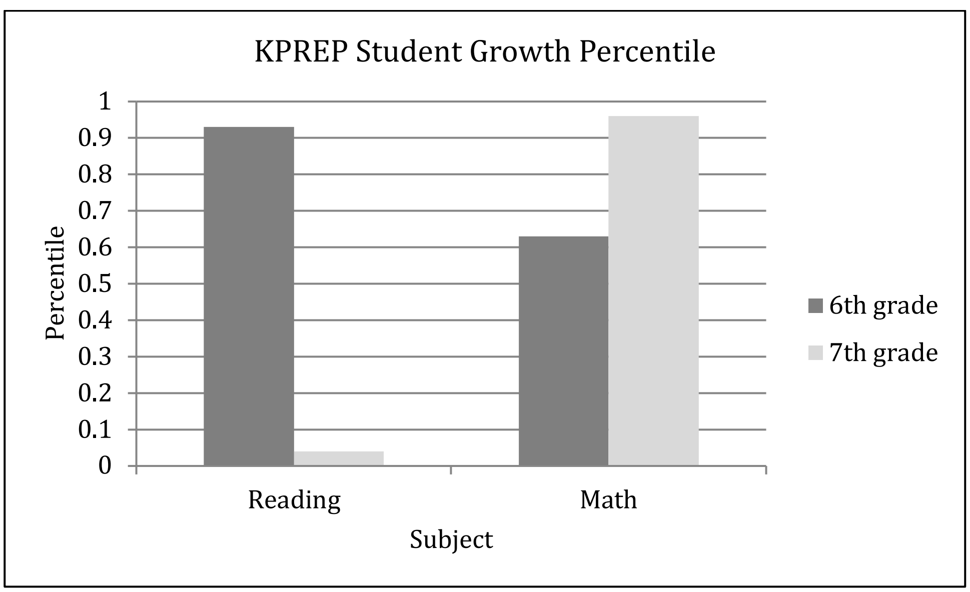

Figure 9. K PREP student growth percentile

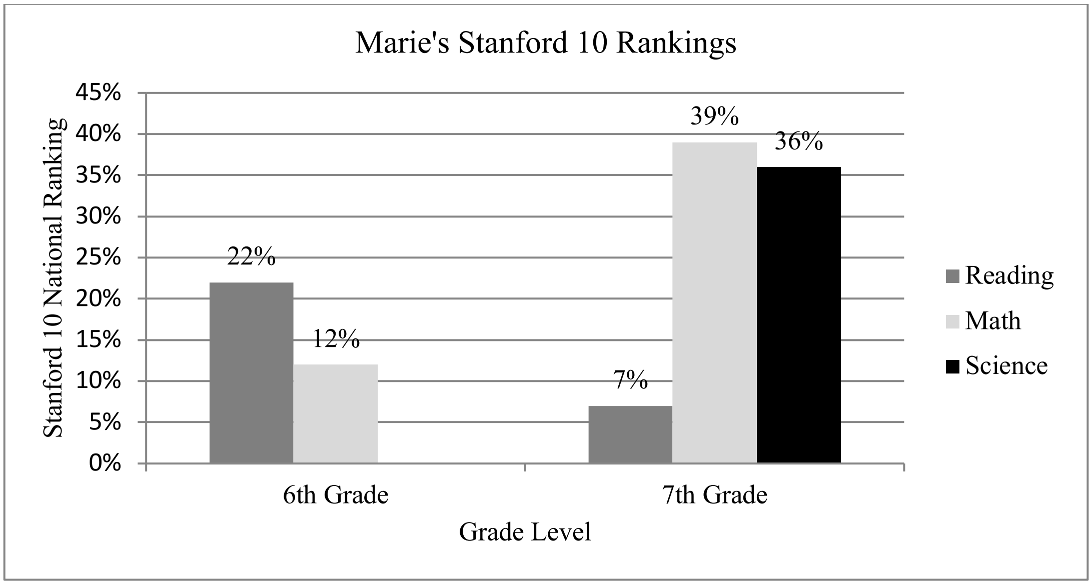

Figure 10. Marie's Stanford 10 rankings

Case 2. Joseph: Fetal alcohol syndrome, mixed expressive/receptive language disorder, developmental coordination disorder (dysgraphia)

At the age of five, Joseph was adopted from Poland. He was removed from his biological mother due to alcohol abuse and neglect which was traumatic. He was diagnosed with fetal alcohol syndrome, a language processing disorder with impairments in both expressive and receptive channels, and developmental coordination disorder. English is his second language.

Assessment

Joseph received an extensive evaluation of his cognitive abilities in 2015 at 8 years of age and further evaluations in 2016 at 10 years of age. The examiner believes that Joseph's difficulties are consistent with a diagnosis of a Mixed Expressive/Receptive Language Disorder (ICD 10: F80.1). This profoundly impacts his ability to learn in a classroom environment (i.e., receptive language) as well as severely limits his capacity to participate in class or group -based activities (i.e., expressive language).

- Very weak visual-spatial processing skills as well as poor fine-motor control, which is likely to profoundly impact his ability to learn, unless accommodations are made to support this challenge. His difficulties are consistent with a diagnosis of a Developmental Coordination Disorder (i.e., dysgraphia, ICD 10 Code: F82).
- Some weakness for sustaining attention and executive functioning, that while likely to significantly impact his daily life at school, is likely to be related to the specific learning challenges described above. At this time, although these challenges would typically be indicative of an attention disorder, it is the examiner's impression that his learning challenges are a better explanation for why he has weakness in tasks of working memory and processing speed.

Intervention

Joseph had been receiving occupational therapy, speech therapy, and educational support at his school. However, he was not able to work independently in class. Brown reviewed the academic and psychological testing showing cognitive deficits in processing, working memory, comprehension, and perceptual reasoning. From April 2015 to January 2017, Joseph received cognitive developmental therapy with *EMCDC* for 30-minute sessions, 5 days a week for 150 hours. The sessions were conducted via online teletherapy. During this time, he also did primitive reflex exercises and listened to sound therapy for a few months.

Results after intervention

Previously, Joseph's working memory was an index score of 80, which is the 9th percentile. In contrast to the 2015 evaluation, the working memory index score increased to 103 and the 58th percentile in the average range conducted in December 2016. The processing speed is considerably higher on the 2016 evaluation, increasing from an index score of 83 to 98 and from the 13th to 45th percentile in the average range (see Table 10).

In March 2017, the Kaufman Test of Educational Achievement-3rd Edition-Form A (KTEA-3) was administered. The KTEA-3 is composed of subtests that measure a student's academic achievement in the areas of reading, written language, and math. Joseph is performing in the average range in all academic areas. When compared to grade norms, Joseph's scores are higher. While he demonstrated average comprehension abilities when reading expository passages and literal questions, he demonstrated weaknesses when reading fictional passages and answering inferential questions. Math concepts and applications are a relative strength for Joseph while math computations are a relative weakness. Joseph performed equally well with written expression and reading (see Table 12).

The current scores are in some way like previous results and in some ways dissimilar. The WISC-V has a different format than the WISC-IV. With one exception, each of the index scores has at least one and sometimes two subtests within the average range, suggesting that Joseph's potential is at least in the average range in all the tested areas, except for one.

Joseph's Vocabulary score was in the middle of the average range. However, as he did on the 2015 WISC-IV, he had extreme difficulty in understanding superordinate concepts. In other words, understanding the relationship to how things are similar. Another way of saying it would be that he had difficulty detecting the conceptual relationship among objects. In the 2015 report, Joseph had very poor visual spatial ability. However, on this measure, there is an addition of another subtest not given on the WISC-IV. On the Block Design subtest, which is a visual spatial task or a task of perceptual analytic reasoning, he scored in the average range and was in the low average range previously. The same is true on a task in which he had to analyze and synthesize visual objects. The index score of 92 falls in the average range. Thus, visual spatial reasoning or perceptual analytic abilities are in the average range, albeit at the lower end of average (see Table 10).

Joseph had the most difficulty in Fluid Reasoning. These tasks require him to detect underlying conceptual relationships among visual objects and then use reasoning to identify and apply the rules. Similarly, as already mentioned, Joseph had difficulty understanding conceptual relationships on a verbal task (Similarities subtest). It should be noted that the examiner who administered the WISC V was not familiar to Joseph and noted significant impulsivity and anxiety during the testing.

However, at 10 years of age, Joseph was administered the Kaufman Brief Intelligence- 2 (KBIT-2) in September 2016 by Brown who had been working with him daily for 1.5 years. The test was given over two days. Joseph exhibited no impulsivity or anxiety and was extremely thoughtful in his responses. The KBIT-2 is a brief intelligence test which measures verbal and nonverbal intelligence for individuals from 4 to 90 years of age which yields three scores: Verbal, Nonverbal, and an IQ Composite. The Verbal scale is composed of two subtests that assess receptive vocabulary and general information (Verbal Knowledge) as well as comprehension, reasoning, and vocabulary knowledge (Riddles). Joseph had a standard score of 102 in the 55th percentile and average range. The Nonverbal scale uses a Matrices subtest to measure the ability to solve new problems by accessing an individual ability to complete visual analogies and understand relationships (Kaufman 2004). Joseph had a standard score of 112 in the 79th percentile in the average range. The IQ composite had a standard score of 109 in the 73rd percentile also in the average range (see Table 11). This is the only assessment administered by Brown. It is Brown's opinion that the difference in fluid reasoning scores on the WISC V and KBIT 2 are a result of the cognitive training and having a relationship with the examiner allowing Joseph to complete the test in optimum conditions. These gains demonstrate the impact of EMCDC on working memory, fluid reasoning, and processing speed. Furthermore, the psychological examiner notes the Full-Scale IQ cannot be used as a fixed figure. There are several indicators on the measure that would suggest average intellect. This would agree with Brown's assessment on the KBIT-2 placing Joseph in the average range.

Table 10. Results of WISC IV and WISC V of Joseph

Scale WISC – IV 01-02/2015	Percentile	Composite Score	Scale WISC –V 12/2016	Percentile	Composite Score	Composite Difference
Verbal	32nd	93	Verbal	18th	86	-7

Comprehension			Comprehension			
Working Memory	9th	80	Working Memory	58th	103	23
Processing Speed	13th	83	Processing Speed	45th	98	15
Perceptual Reasoning	14th	84	Visual Spatial	30th	92	8
			Fluid Reasoning	8th	79	
			Full Scale IQ	21st	88	

Table 11. Results of KBIT-2 of Joseph

Scale KBIT-2 02/2016	**Standard Score**	**Percentile**
Verbal	102	55
Nonverbal	112	79
IQ	109	73

Table 12. Results of KETA-3 of Joseph

Scale KETA-3 03/2017	**Standard Score**	**Percentile**

Reading Composite	99	47
Math Composite	96	42
Written-Language Composite	98	45

In conclusion, Joseph has shown strong cognitive modifiability throughout the program with *ECMDC*. He has an incredible work ethic and maintains a positive growth mindset. Joseph's visual and verbal memory, visual- spatial memory, working memory, processing, and reasoning skills have developed significantly. He is giving more attention to detail, following 3- to 4-step directions, and verbalizing his thought process.

Case 3. David: Autism, apraxia, anxiety, and Hashimoto's disease

David is an eleven-year-old boy with a diagnosis of Autism and verbal apraxia at two years, eight months of age. He was also diagnosed with Hashimoto's Disease in December of 2010. David's school performance is below average. He has received Applied Behavior Analysis (ABA) therapy, speech therapy, and occupational services for many years. He struggles with anxiety, atypical social behavior, and preservation on topics.

Assessment

At the age of 8, David received an extensive evaluation of his cognitive abilities in 2015 and further evaluations in 2016. In 2015 the processing speed index (PSI) of the WISC IV was given to David with a PSI of 73 as seen in Table 13. The Kaufman Brief Intelligence- 2 (KBIT-2) was also given in 2015. The verbal scale is composed of two subtests that assess receptive vocabulary and general information (Verbal Knowledge) as well as comprehension, reasoning, and vocabulary knowledge (Riddles). David had a standard score of 61 in the below average range. The Nonverbal scale uses a Matrices subtest to measure the ability to solve new problems by accessing an individual ability to complete visual analogies and understand relationships (Kaufman 2004). David had a Nonverbal standard score of 66 in the below average range. The IQ composite had a standard score of 58 also in the below average range for an Intellectual Disability as seen in Table 14.

The Wechsler Individual Achievement Test-III was given to David in 2015. The examiner noted severe difficulties academically with severely impaired scores in early reading, math problems and listening comprehension. Spelling was in the low average range and alphabet writing in the average range. Word reading and numerical operations were in the moderately impaired range as seen in Table 15.

Intervention

David received cognitive developmental therapy with Equipping Minds Cognitive Development Curriculum from February 2015 to May 2017 for 20- to 30-minute sessions, 5 days a week for a total of 160 hours. The sessions were conducted via online teletherapy.

Results after intervention

After receiving cognitive intervention with *EMCDC* for 1.5 years, David was referred for a psycho-educational re-evaluation in September 2016 to determine continued special education eligibility and placement. He was previously identified as a student with an autism spectrum disorder.

The WISC-V was the assessment given for the reevaluation to assess David's performance across five areas of cognitive ability. As measured by the WISC-V, his overall FSIQ score fell in the Below Average range when compared to other children his age (FSIQ = 72) which was an increase of 14 points from the FSIQ of 58 in 2015. Furthermore, he showed average performance when working with primarily visual information and the VSI demonstrates an area of strength relative to his overall ability (VSI = 97). When compared to his fluid reasoning (FRI = 85), working memory (WMI = 74), and processing speed (PSI = 77) performance, visual spatial skills emerged as a particular strength (see Table 13).

Results of standardized achievement testing on the Kaufman Test of Educational Achievement-3rd Edition-Form A given in 2016 suggest that David is performing within the average range for the area of spelling. The areas of letter/word recognition, silent reading fluency, reading comprehension, math computation, and math concepts/applications were found to be within the below average range. The assessment instruments used provide a comprehensive set of individually administered norm-referenced tests for measuring academic achievement. It should be noted that norm-referenced assessments do not test curriculums benchmark, or the amount of instruction needed to achieve benchmarks. These tests provide a measure of David’s academic achievement as compared to peers of the same age using a standard score. His test performance can be generalized to similar, non-test, age-level tasks (see Table 15).

In analyzing the results on the Wechsler Individual Achievement Test-III given in 2015 and the Kaufman Test of Educational Achievement-3rd Edition-Form A given in 2016, David made significant gains in reading abilities, letter/word recognition, silent reading fluency, reading comprehension, math computation, and math concepts/applications moving from severely impaired in 2015 to below average range 1.5 years later. Spelling moved from below average to the average range. (see Table 15). In conclusion, the academic and cognitive gains which David has shown indicate strong cognitive modifiability in many areas. His social skills also improved, impacting his relationships with peers.

Table 13. Results of WISC IV, WISC V and KBIT-2 of David

Scale WISC – IV 01/2015	Composite Score	Scale WISC –V 09//2016	Composite Score	Difference	
		Verbal Comprehension	62		below average
		Working Memory	74		below average
Processing Speed	73	Processing Speed	77	4	below average
		Visual Spatial	97		average
		Fluid Reasoning	85		average
KBIT-2 IQ Composite	58	Full Scale IQ	72	14	below average

Table 14. Results of KBIT-2 of David

KBIT-2 01/2015	Standard Score	KBIT-2 09/2016	Standard Score	Difference	
Verbal	61	Verbal	69	8	below average
Nonverbal	66	Nonverbal	122	56	average
IQ Composite	58	IQ Composite	95	37	average

Table 15. Results of WIAT-III of David

Scale WIAT-III 01/2015	Standard Score	Scale KETA-3 09/2016	Standard Score	Difference
Early Reading Skills	40	Reading Composite	73	33
Word Reading	70	Letter and Word Recognition	77	7
Listening Comprehension	53	Reading Comprehension	71	18
Receptive Vocabulary	66	Silent Reading Fluency	78	12
Expressive Vocabulary	55	Math Composite	73	18
Math Problem Solving	51	Math Concepts and Application	68	17
Numerical Operations	71	Math Computation	81	10
Spelling	83	Spelling	86	3

Case 4. Kay: General learning disorder

Assessment

Kay's parents have been concerned about her cognitive abilities since the first evaluation when she was 7 years of age. At that time, her Full-Scale IQ on the WISC-IV was 72. Her Verbal Comprehension Index is 79, Perceptual Reasoning is 94, Processing Speed is 73, and Working Memory is 56 as seen in Table 13. Kay performs better on nonverbal than verbal reasoning tasks. At the age of 15 years, Kay had another educational evaluation. On the Slosson Full – Range Intelligence test, Kay received a Full – Range IQ score of 85. The verbal index score was 88, the memory index standard score was 80, and the performance index standard score is 84. All three of these index scores: 88, 84, and 80 are consistent with Kay's overall IQ score of 85 as seen in Table 15.

Academic testing had been done with the Woodcock Johnson Test of Achievement III (WJ-III) from 2010- 2016. In April 2010, the WJ-III results indicated Kay was in the average range in broad math and math calculations. Oral expression, basic reading, and math reasoning, and listening comprehension were in the low average range (see Table 17). She has been home-schooled by her mother for her academic career. In 2013, the Peabody Individual Achievement Test was given. Kay had a standard score of 84 (14^{th} percentile) in general information, standard score of 71 (3^{rd} percentile) in reading recognition, a standard score of 70 (2^{nd} percentile) in reading comprehension, standard score of 67 (1^{st} percentile) in total reading, standard score of 74 (4^{th} percentile) in mathematics, standard score of 76 (5^{th} percentile) in spelling, and a standard score of 71 (3^{rd} percentile) in written language (see Table 18).

Intervention

Kay received cognitive developmental therapy with *EMCDC* from September 2015 to May 2016 for 30-minute sessions, 5 days a week for 60 hours. The sessions were conducted via online teletherapy. She was 17 years of age.

Results after intervention

After completing 60 hours with EMCDC, Kay took the Woodcock Johnson Test of Achievement III as she does every year as seen in Table 19. In analyzing the results from 2010-2014, Kay typically made gains of 6 months to 1 year. At a 9.8 grade level in 2014, Kay's scores ranged from 4.2 – 7.0 in most subjects putting her 2 to 5 years below grade level. However, Kay made significant gains in Grade Equivalent (GE) and Age Equivalent (AE) on the 2016 assessment where she was 11.8 GE and 18.2 AE in the following areas:

- Oral language went from a 4.4 GE to 17.6 GE for a gain of 13.2 years
- Written expression went from 7.6 GE to 12 GE for a gain of 4.4 years
- Understanding Directions which encompasses working memory went from 4.5 GE to 18 GE for a gain of 13.5 years
- Math Calculations went from 9.5 GE to 11.2 GE for a gain of 1.7 years
- Writing Fluency went from 7 GE to 13 GE for a gain of 6 years
- Story Recall went from 5.6 GE to 13 GE for a gain of 7.4 years

The same examiner has given the test for numerous years and indicated that gains of this magnitude had not been seen and is atypical of someone with Kay's long academic history of learning challenges. The gains correspond with the cognitive developmental therapy with EMCDC which Kay received during September 2015 to May 2016. She had previously been receiving academic tutoring alone. In conclusion, the academic gains which Kay has shown indicate strong cognitive modifiability in many areas. As her processing and working memory abilities increased, Kay was able to successfully complete her high school coursework and start her own photography business.

Table 16. Results of WISC IV for Kay

Scale WISC –V 12/2005	Composite Score	Percentile	
Verbal Comprehension	79	8	low
Working Memory	56	.2	low
Processing Speed	73	4	low
Perceptual Reasoning	94	34	average
Full Scale IQ	72	3	low

Table 17. Results of Slosson for Kay

Scale 03/2013	Composite Score	Percentile	
Verbal Index	88	8	low
Memory Index	80	.2	low
Performance Index	84	4	low
Full Scale IQ	85	3	below average

Table 18. Peabody Individual Achievement Test for Kay

2013	Standard Score	Percentile
General Information	84	14
Reading Recognition	71	3
Reading Comprehension	70	2
Mathematics	74	4
Spelling	76	5
Written Expression	71	3

Table 19. Results Woodcock Johnson III Normative Tests of Achievement of Kay

	GE:5.8	GE:6.8	GE:7.8	GE:9.8	Score after intervention Grade: 11.8	Difference
	2010	2011	2012	2014	2016	
Oral Language	3.7	3.5	4.6	4.4	17.6	13.2
Brief Achievement	3.2	3.7	4.2	4.6	6.5	1.9
Broad Reading	2.8	3.1	3.9	4.7	6.6	1.9
Broad Math	5.2	5.7	6.3	7	7.2	0.2
Broad written language	3.3	4.3	4.8	6.3	8.9	2.6

Brief Reading	2.9	3.3	4.1	4.8	7	2.2
Brief Math	5.1	5.5	6.3	6.6	7.2	0.6
Math Calc Skills	6	6.4	8.1	9.2	9.2	0
Brief Writing	3	4.1	4.7	5.9	8.1	2.2
Written expression	3.9	5.1	5.5	7.6	12	4.4
Academic Skills	3.6	4	5.1	5.5	7.8	2.3
Academic Fluency	3.6	4.3	4.7	6.4	7.6	1.2
Academic Apps	3.6	4.5	4.7	5.9	6.7	0.8
Academic Knowledge	3.4	3.4	4.5	4.8	7.1	2.3
Letter Word ID	3	3.2	4.2	4.3	7.2	2.9
Reading Fluency	2.4	2.4	3.2	4.3	5.5	1.2
Understanding Directions	4.1	2.4	5.1	4.5	18	13.5
Calculations	6.4	6.4	9.5	9.5	11.2	1.7
Math Fluency	5.4	6.7	6.6	8.7	7.5	-1.2
Spelling	2.7	3.4	3.7	4.8	6.9	2.1
Writing Fluency	3.9	4.9	4.9	7	13	6
Passage Com	2.7	3.5	3.9	6	6.7	0.7
Applied Prob	4.2	4.7	4.5	4.8	5.2	0.4
Writing Sample	3.8	5.5	6.7	8.7	11.4	2.7
Story Recall	1.8	1.8	2.7	5.6	13	7.4
Academic Knowledge	3.4	3.4	4.5	4.8	7.1	2.3

Case 5. Steven: Fetal alcohol spectrum disorder, post-traumatic stress disorder, autism, mixed receptive-expressive language disorder, ADHD, specific learning disorder, anxiety

Steven was adopted from Russia at the age of 5 years. He has a history of mild alcohol related neurodevelopmental disorder in addition to psychosocial growth failure and post-traumatic stress disorder. English is his second language.

Assessments

Steven has been evaluated by the pediatric endocrinologist for growth issues as he has been below the 10th percentile which was consistent with the initial neuropsychological evaluation. Steven is on medication for ADHD and has Lyme disease. He has a history of strabismus with residual exotropia which was addressed in developmental optometry. The diagnostic conclusions indicated a mixed receptive-expressive language disorder; multi-sensory neuropsychologically-based processing deficits related to an alcohol related neurodevelopmental disorder/static encephalopathy in addition to multiple learning disabilities in the category of developmental dyslexic disorder. Steven certainly had a great deal of anxiety which is very commonly seen in children who have multi-sensory neurocognitive deficits.

Steven's overall neuropsychological history indicates that he was evaluated at the age of 10 years of age with a pattern of global weaknesses in receptive and expressive language as well as processing and learning deficits. Many of these issues were related to mild alcohol-related neurodevelopmental disorder with some quasi-autistic characteristics in addition to multisensory information processing impairments. After the neuropsychological evaluation, Steven received special education services throughout his school years and was re-evaluated at the start of his tenth-grade year in January of 2012.

Steven's initial intellectual testing completed in 2005 yielded a verbal comprehension score of 75; perceptual reasoning score of 92; working memory score of 77; processing speed score of 97; and a Full-Scale IQ score of 81. Gaps and inconsistencies in nonverbal learning aptitudes and abilities as well as receptive and expressive language were evident.

In the updated evaluation in 2012, Steven was administered the Wechsler Intelligence Scale for Children – Fourth Edition and obtained a verbal comprehension score of 79; perceptual reasoning score of 88; working memory score of 83; processing speed score of 94; and a Full-Scale IQ of 81 which was the sale score in 2005 (See Table 20).

Steven also showed ongoing indications of a mild Autistic Disorder given his difficulties in relating to others as well as anxiety, stress and struggles with adapting to change as well as expressive pragmatic language. He also had definite problems in comprehension and higher-level listening responses in addition to gaps and inconsistencies in attention, memory, learning and overall information processing and problem solving. Academic-achievement abilities indicated weaknesses in reading style, rate and written language with relative strengths in mechanical math but difficulties in mental calculations and word problems. Steven always struggled with expressive writing in addition to memory processing and consolidation in both auditory and visual spheres. He also had significant patterns of executive dysfunction. Over the years, Steven has been receiving special education services through his school district and has made gradual progress.

Intervention

Steven received cognitive developmental therapy with *EMCDC* from January 2015 to May 2015 for 60-minute sessions, 5 days a week for 60 hours. The sessions were conducted via online teletherapy. Steven also did 15-20 minutes of primitive reflex integration therapy and 60 minutes of sound therapy daily for a few months.

Results after intervention

After completing cognitive developmental therapy with *EMCDC*, his parents stated that Steven showed reduced anxiety, increased eye contact, was more socially aware, and demonstrated a sense of humor and math sense. His overall language and language arts abilities have improved with cognitive therapy, and he has improved in his overall academic performance and cognitive abilities (See Table 20). Steven no longer needs to take ADHD medication.

In July 2015, Steven was administered the Wechsler Adult Intelligence Scale – Fourth Edition and showed a more stable pattern in his overall intellectual abilities which are now within the Average Range although he has a 21-point discrepancy between verbal comprehension and perceptual reasoning which indicates an ongoing language weakness pattern. As a general summary statement, there is no question that Steven has improved on a global perspective in terms of neurocognitive or neuropsychiatric functioning after completing 60 hours of *EMCDC.* His processing speed increased 12 points, his perceptual reasoning increased 9 points, and his IQ increased 8 points as seen in Table 20. He is much more alert, oriented, and interactive as well as motivated to do well with a lessening of the neurocognitive effects of a fetal alcohol spectrum disorder in addition to his autistic spectrum disorder which has always been at the "higher-functioning spectrum." In terms of pure academic-achievement abilities, Steven is at the middle school level in overall reading, reading comprehension, spelling, written language, and mathematics. This certainly is a significant improvement as it shows that he has enough neurocognitive and academic skills in order to function at the technical-vocational training level. His strengths are in the areas of hands-on visual assimilative learning which is his area of interest and strength. Steven graduated from high school and is currently employed.

Table 20. Results of WISC IV for Steven

Scale WISC – IV	Composite Score 2005	Composite Score 2012	Composite Score 07/2015	Difference
Verbal Comprehension	75	79	76	-3
Working Memory	77	83	80	-3
Processing Speed	97	94	106	12
Perceptual Reasoning	92	88	97	9
Full Scale IQ	81	81	89	8

Case 6. Bryant: Post-traumatic concussion syndrome

At 18 years of age Bryant experienced a head injury during a rugby game. The doctors recommended antidepressants and extended rest. As the symptoms increased, he tried various treatments over the next four years from acupuncture to chiropractic treatments. However, the symptoms were not alleviated. He then took one year off and had given up. He was 23 years of age when beginning cognitive training with *EMCDC*.

Assessment

- Interview with learner
- Equipping Minds Learning Screening Checklist
- Equipping Minds Primitive Reflex Checklist

Below is a list of the most prominent symptoms Bryant experienced after the concussion.

- Fogginess: One of my most prominent symptoms is what can only be described as a feeling of fogginess. When in this state, it is hard to complete most mental tasks. It felt as if my neurons were trying to fire and make connections but didn’t have a clear pathway to do so.
- Difficulty with concentration and attention: Within this state Bryant had a difficult time concentrating on tasks and paying attention for extended periods of time.
- Poor working memory: Difficulty following multiple step directions
- Long term memory retrieval: Difficulty remembering names of people
- Language retrieval and processing: Difficulty recalling vocabulary
- Extreme physical and mental fatigue: Mental fatigue is like the fogginess but manifests itself in fatigue-like symptoms. For example, during reading Bryant would have to fight off an intense desire to sleep and could no longer concentrate on whatever was being read.
- Depression

Intervention

In October of 2016, Bryant contacted Brown to discuss using *EMCDC* to strengthen his cognitive deficits because of Post Traumatic Concussions Syndrome. According to Bryant he has tired numerous interventions over the last 5 years with little relief. Brown agreed to have an EMCDC mediator begin working with Bryant using *EMCDC*. Bryant received cognitive developmental therapy with EMCDC from September 2016 to April 2017 for 30- to 60-minute sessions, 5 days a week for a total of 100 hours. The sessions were conducted via online teletherapy. Bryant also did 15-20 minutes of primitive reflex integration therapy and 60 minutes of sound therapy on a daily basis during this time.

Results after intervention

After completing 100 hours of intervention with *EMCDC***,** Bryant reported the following results.

- Decreased fogginess: After working with EMCDC, the periods and intensity of fogginess have significantly decreased. The exercises we focused on strengthened those connections and helped my brain work around its deficits.
- Increased concentration and attention: Bryant reports having a much easier time holding attention and concentrating on specific tasks.
- Increase in working memory: Able to follow multi-step directions
- Long term memory: Able to store information and retrieve information much easier
- Increased stamina and energy: His stamina and energy has significantly improved while performing cognitive tasks.
- Enjoying reading and learning
- Spending extended time outside without being symptomatic

Bryant's improvements continue and he can work fulltime and is asymptomatic.

Case 7 Scott: Anxiety, Autism, Developmental Coordination Disorder, Borderline Intellectual Functioning

At the age of 2.5 years, Scott was adopted from China. English is his second language.

Assessment

At six years of age, Scott received a cognitive evaluation in 2010 and further evaluations in 2015 at 10 years of age, 2017 at 12 years of age, and 2020 at 15 years of age. The examiner believes that Scott's difficulties are consistent with a mixed diagnosis of Anxiety, Autism, and Developmental Coordination Disorder. Scott had received physical therapy, speech therapy, occupational therapy, and Applied Behavior Analysis (ABA) therapy. He has been homeschooled and has attended a private school.

Intervention

Scott received cognitive developmental therapy with *EMCDC* from June 2019 to March 2020 for 60-minute sessions, 5 days a week for a total of 60 hours. The sessions were conducted via online teletherapy. Scott also did 15-20 minutes of primitive reflex integration therapy and 60 minutes of sound therapy daily for 10 months.

Results after intervention

Scott made unprecedented gains on his cognitive testing. Table 21 includes cognitive testing over ten years. His Full-Scale IQ increased 41 points from 80 in 2017 to 121 in 2020 moving him from a borderline intellectual disability to the superior range. His verbal comprehension increased 19 points, visual spatial increased 30 points, fluid reasoning increased 32 points, working memory increased 28 points, and processing speed increased 10 points. He was faithful in doing the primitive reflex exercises and listening to the sound therapy daily. Due to the pandemic of 2020, the school did not conduct year end academic testing. However, he made all A's and a B+ in geometry. His social skills were also significantly impacted.

Table 21. Results of WISC IV and WISC V for Scott

	Oct. 2010	**Feb. 2015**	**March 2017**	**May 2020**	
Verbal Comprehension	VIQ 88	103	89	108 average	+19
Visual Spatial		78	92	122 superior	+30
Fluid Reasoning	PIQ 82	100	74	106 average	+32
Working Memory		76	97	125 superior	+28
Processing Speed		77	98	108 average	+10
Full Scale	83	89	80	121 superior	+41

Case 8 Jackson: Specific Learning Disorder with Impairment in Reading, Specific Learning Disorder with impairment in written expression, ADHD, Other Specified Anxiety Disorder

Jackson is an eight-year-old boy. In 2019, an evaluation determined he met criteria for Specific Learning Disorder with impairment in reading (Dyslexia) and impairment in written expression, and Other Specified Anxiety Disorder. In 2021, he was diagnosed with

Attention-Deficit/Hyperactivity Disorder. He received speech therapy in kindergarten to address articulation.

Assessment

Cognitive results from the WISC-V indicated an overall Full-Scale IQ (SS=119; 98th percentile) at the top of the High Average range, Extremely High Comprehension (SS=133; 99th percentile), Average Visual Spatial (SS=97; 42th percentile), High Average Fluid Reasoning (SS=115; 84th percentile), Average Working Memory (SS = 91; 27th percentile) and Average Processing Speed (SS=92; 30th percentile). The Wechsler Individual Achievement Test (WIAT)III indicated a Reading Composite (83; 13th percentile), Word Reading (90; 25th percentile), PseudoWord Reading (76; 5th percentile), and Spelling (89; 23rd percentile).

Intervention

Jackson received cognitive developmental therapy with Equipping Minds Cognitive Development Curriculum from August 2020 to March 2021 for 30-minute sessions, 5 days a week for a total of 70 hours. He also did a phonics-based reading intervention for an hour a day, four days a week. These sessions were conducted via online teletherapy. He also received occupational therapy twice a week for part of the school year.

Results after Intervention

In March 2021, Jackson completed a virtual administration of the core WISC-V subtests with the exception of Block Design with Dr. Brown. Results from this administration indicated a Very High overall Full Scale IQ (SS=128; 97th percentile) which was a gain of 9 points, Extremely High Verbal Comprehension (SS=142; 99th percentile) which was a gain of 9 points, High Average Fluid Reasoning (SS=118; 88th percentile) which was a 3-point gain, High Average Working Memory (SS=117; 87th percentile) which was a 26-point gain, and Average Processing Speed (SS=108; 70th percentile) which is a 16-point gain. Additional testing was also done at the testing center which had conducted the assessments in 2019. The Kaufman Brief Intelligence Test, Second Edition (KBIT-2) placed Jackson in the High Average for his overall intellectual abilities (88th percentile) with his verbal skills in the High Average range (SS=112; 79th percentile) and nonverbal skills in the High Average range (SS=119; 90th percentile) which is consistent with the WISC-V. The WIAT-III showed improvements in several areas since his 2019 testing. Specifically, Jackson's Total Reading Composite increased from 83 and the 13th percentile to 92 and the 39th percentile. Word Reading increased from 90 and the 25th percentile to 101 and the 51st percentile. Pseudoword Reading increased from 76 and the 5th percentile to 92 and the 30th percentile. Spelling scores improved from 89 and the 23rd percentile to 94 and the 34th percentile placing him in the Average range and High Average range in Reading Comprehension with a score of 113 and the 81st percentile.

The results from the cognitive testing indicate that overall abilities are in the utmost end of High Average range with significant gains in processing speed and working memory. The severity of his reading disorder is considered mild at this time. The combination of cognitive training with the Orton-Gillingham phonics-based reading instruction proved beneficial for Jackson cognitively and academically demonstrating far transfer effects.

Discussion

Cognitive and academic gains are demonstrated in each of the learners. These results confirm that learners who have multiple neurodevelopmental disabilities benefit from a multi-component and multi-domain cognitive training program. Whereas six of the seven learners received the program through an online format, it expands the options for implementation by interventionists and educators. Finally, three of the learners were international adoptions, experienced trauma, and English was their second language which were additional challenges that impacted learning for each of them.

Research with Specific Learning Disorders using Equipping Minds

The purpose of the author's doctoral research (Brown 2016) was to examine the effect of the *Equipping Minds Cognitive Development Curriculum* (*EMCDC*) on working memory in students diagnosed with specific learning disorder (SLD), a neurodevelopmental learning disorder, and whether an increase in working memory resulted in transfer effects within an educational setting, measured by standardized tests of academic attainment and non-verbal and verbal abilities. Additionally, this study explored differences with gender and age (Brown 2016).

Strengths of the Research Design Method

In response to the critiques of cognitive training research, the following concerns were addressed (Mebly-Lervag & Hulme, 2013; Novick et al 2020). First, the research design was a true quantitative experimental design with a random allocation of 32 participants into a training and active control group. The training group received 30 hours of cognitive training and the active control group participants received 30 hours of academic training with a teacher for 60 minutes, 5 days a week for 7 weeks in a small group strengthening the results. The statistical analysis was done by a statistician, and a regression output was used to determine if the difference in pre- to post-test scores could be statistically attributed to the training strengthening the validity of the intervention with *EMCDC*.

At the time of the pre-test, the participant's allocation into the groups had not been disclosed to the participants or testers, which was also a strength. Second, another strength of the design was the cooperative attitude, commitment, and fidelity to the intervention by the school administration, faculty, parents, mediators, and participants. No compensation was given to the participants. All 32 participants completed the entire study. The participants in the training and active control group had rapport with the testers, which brings out the participants' best performance. Third, multi-measures of testing examined verbal and visuospatial working memory, verbal and nonverbal abilities, IQ composite, and academic attainments in nine areas. Finally, utilizing the schools yearly academic test, *Terra Nova*, allowed a comparison of two years of testing strengthening the finding that *EMCDC* has statistically significant gains to academics.

Weaknesses of the Research Design

The major weakness of the research design was the time constraint. For optimum results from the *EMCDC*, Brown recommends a minimum of 60 hours of intervention over a

12- to 24-week period which was done in the case studies with *EMCDC.* The participants were limited to a 9-week period to complete the pre-testing with the *AWMA*-2 and *KBIT*-2, the 30 hours of intervention, and the post-testing with the *AWMA*-2 and *KBIT*-2. The participants had Spring break the first week of April and then the *TerraNova* testing. Finally, the time for the study did not allow follow-up assessments to determine if the gains were maintained.

Method

In phase one, a private school who serves learners with SLD initiated contact with Equipping Minds which allowed access to potential participants in the study. The initial information about the study was delivered to the school administration to confirm the willingness of the school, parents, and students to participate in the study. The school administration identified 32 potential participants in grades 4–8 who were between nine and fourteen years of age and had completed the *TerraNova* academic testing in 2015 at the school. The school administration provided the diagnostic assessments on each student which also included IQ scores with working memory subtest scores. It was confirmed that potential participants had a diagnosis of SLD and had completed the 2014-2015 *TerraNova* academic assessment prior to the beginning of the study. The parents of the 32 potential participants completed a Student Participation Consent Form prior to beginning the study. The eight training groups required 4 *EMCDC* mediators who were trained in *EMCDC* for the study.

In phase two, the school administration randomly allocated the 32 participants to either the active control or the training group upon receipt and examination of all the participation forms. The decision was made to place 16 participants in the training group with 7 males and 9 females: and 16 participants in the active control group with 7 males and 9 females. It should be noted that all 32 participants completed the entire research study. Qualified professionals administered a pretest with the *Kaufman Brief Intelligence Test,* 2nd ed. (*KBIT*-2), a brief intelligence test which measures verbal and nonverbal intelligence for individuals from 4 to 90 years of age. The test takes 15-30 minutes to administer and yields three scores: Verbal, Nonverbal, and an IQ Composite. The Verbal scale is composed of two subtests that assess receptive vocabulary and general information (Verbal Knowledge) as well as comprehension, reasoning, and vocabulary knowledge (Riddles). The Nonverbal scale uses a Matrices subtest to measure the ability to solve new problems by accessing an individual ability to complete visual analogies and understand relationships (Kaufman 2004). At the time of the pre-test the participant's allocation into the groups had not been disclosed to anyone testing the participants. The testing took place at the school and took approximately 30 minutes for each participant to complete.

Qualified professionals administered a pretest with a beta version of the *Automated Working Memory Assessment 2nd ed.* (*AWMA*-2) on a computer in the school's computer lab. At the time of the pre-test the participant's allocation into the groups had not been disclosed to anyone testing the participants. The *AWMA*-2 was designed to provide classroom teachers and specialists with a tool to identify working memory difficulties quickly and easily. The tests used in the computerized *AWMA*-2 battery were selected based on research establishing that they provide reliable and valid assessments of verbal and visual-spatial short term and working memory. The *AWMA*-2 was piloted with children and adults with autism spectrum disorders, ADHD, dyslexia, and motor disorders. The tests were also piloted on two groups of children: young children (4-5 years) and older children (9-10 years). The tests were adjusted to ensure that both the practice and test trials were age-appropriate and extensive practice trials with visuals were included. The *AWMA*-2 was field tested for five years and the feedback received from educators, psychologists and other professionals helped to refine the current version. The *AWMA*-2 was standardized to include individuals ages 5–79 years (Alloway 2011a).

As noted, all the participants had completed the *TerraNova* academic testing in 2015. *TerraNova* is a standardized academic assessment for 2nd-12th grade students in reading, mathematics, language, science, social studies, and spelling. The *TerraNova* is a respected and valid national achievement test for reading, mathematics, language, science, social studies, and spelling. *TerraNova* features 2011 norms from a national study. These are the most current and accurate norms, which allow educators to compare achievement results between groups of students. With item alignments to state standards, educators can review student results in the context of common school and district criteria. The academic assessment the school already had in place was used, as it would have been a burden on the school and participants to add an additional academic assessment. This also strengthened the results of the academic assessments as all the students attended the same school for two years. The only difference between the students was either seven weeks of intervention in the training group with cognitive developmental training or seven weeks of intervention in the active control group with academic training.

In phase three, the participants in the training group received cognitive developmental training for 60 minutes, 5 days a week for seven weeks in a small group of two participants with a trained mediator using *EMCDC*. The "*Maintaining Brains Everyday*" program for the primitive reflex exercises (Johnson, 2015) was done by the participants at home or at school for 15 minutes a day. The sensory-motor development exercises included the use of sound therapy (Joundry, 2005) which the participants wore during the one-hour intervention sessions while doing the cognitive developmental exercises. The mediators follow an abbreviated format of the *EMCDC* full program as the intervention was limited to 30 hours. Brown observed the training groups on a weekly basis to assure fidelity to the *EMCDC* research protocol. Brown was also available to answer questions from the mediators and observe the participants' progression. The participants in the active control group received academic training with a teacher for 60 minutes, five days a week for seven weeks in a small group. All participating learners continued to receive standard special educational support services because of their learning difficulties.

In phase four, a qualified professional administered a post-test with the *KBIT*-2 which took approximately 30 minutes for the active control group as noted in the pretest. However, the training group took approximately 45 minutes to complete the post-test. Those administering the test noted more thoughtful responses by those in the training group. The *AWMA*-2 was administered on a computer by qualified professionals. The *TerraNova* academic testing was administered by the school administration and faculty over a 2-week period. The school principal confirmed the completion of *TerraNova* by the participants.

Data analysis

In phase five, the results of all three tests were compiled on Excel spreadsheets. A statistician then conducted a statistical analysis of the data collected on the *AWMA-2*, the *KBIT*-2, and the *TerraNova*. To examine the gains as a function of cognitive developmental training, a statistician subtracted the pre-test scores from the post-test scores and compared the difference in scores (Time 2-Time 1) as a function of the group. Scores below 0 indicate a worse performance on the post-test. Scores above 0 indicate improvements the group made after training. A regression analysis was performed to determine the effect of training using *EMCDC.*

Findings

Research Question 1 asked, "What, if any, are the effects on working memory when applying the *Equipping Minds Cognitive Development Curriculum*?" The results demonstrate that there was a statistically significant improvement in Verbal Working Memory test scores for the students in the training group ($t_{(15)} = 2.459$, $p = .0265$). Students in the training group also showed improvement on the Visuospatial Working Memory but the improvements were not statistically significant. The students in the active control group only showed improvement in Verbal Working Memory but the improvements were not statistically significant and showed a decrease in visuospatial working memory (see Table 22).

When applying a regression analysis, the results demonstrate that we are unable to conclude that the training provided by the *Equipping Minds Cognitive Development Curriculum* made a significant effect on the improvement in test scores for the students on the two Working Memory tests. While the average gain made by students in the training group was larger than the active control group on each Working Memory test, the difference that can be attributed to the training is not statistically significant (see Table 23).

In response to Research question 1, "What, if any, are the effects on working memory when applying the *Equipping Minds Cognitive Development Curriculum*?" one must conclude there is no statistically significant effect on working memory when applying the *Equipping Minds Cognitive Development Curriculum*.

Table 22. Working memory scores for SLD

Measures	Active Control			Training Group		
	M	$t_{(15)}$	Pre-to-Post (p)	M	$t_{(15)}$	Pre-to-Post (p)
Verbal WM	2.125	1.152	.2671	3.875	2.459	.0265 *
Visuo-Spatial WM	-1.063	-0.327	.7480	4.313	1.519	.1495

Note: M = Mean of the post- minus pre-test scores; *p* = *p*-value for the two-mean *t*-tests for the difference in pre- and post-test scores; * = significant at the 5% level.

Table 23. Regression analysis: effect of training on working memory scores for SLD

Measures	Training B (S.E.)	p	r^2
Verbal WM	1.750 (2.425)	.4761	.0171
Visuospatial WM	5.375 (4.313)	.2223	.0492

Note: B = regression coefficient of the training effect on the difference in post- minus pre-test scores; SE = standard error of the regression coefficient; *p* = *p*-value for the significance of the training on the difference in test scores; * = significant at the 5% level.

Research question 2 asked, "What, if any, are the effects of changes in working memory to academic abilities in learners using the *Equipping Minds Cognitive Development Curriculum*?" The results demonstrate that there was a statistically significant improvement in the reading ($t_{(15)} = 2.249$, $p = .0399$), science ($t_{(15)} = 4.050$, $p = .0010$), and spelling ($t_{(15)} = 3.735$, $p = .0019$) test scores for the students in the training group. Students in the training group showed improvement on each academic test aside from computation, but the other improvements were not statistically significant. The improvement shown by students on any of the academic tests in the active control group was not statistically significant. (see Table 24). When applying the regression analysis, the findings demonstrate that we are able to conclude that the training provided by the *Equipping Minds Cognitive Development Curriculum* made a significant effect on the improvement in test scores for the students on the science test ($r^2 = .1273$, $p = .0450$). While the average gain made by students in the training group was larger than the active control group on every test other than math and computation, the difference that can be attributed to the training is not statistically significant for any of the other tests see Table 25).

Table 24. Grade equivalent academic scores for SLD

Measures	**Active Control**			**Training Group**		
	M	$t_{(15)}$	Pre-to-Post (p)	M	$t_{(15)}$	Pre-to-Post (p)
Reading	0.250	0.324	.7508	1.069	2.249	.0399 *

Vocabulary	0.150	0.204	.8411	0.806	1.241	.2336
Language	1.081	1.674	.1148	1.169	1.722	.1055
Mechanics	-0.594	-0.754	.4624	1.131	1.498	.1549
Math	0.819	1.622	.1256	0.500	1.191	.2521
Computation	0.775	1.449	.1679	-0.113	-0.234	.8181
Science	0.019	0.032	.9745	1.438	4.050	.00105 **
Social Studies	0.844	1.260	.2268	0.950	1.239	.2345
Spelling	0.656	1.361	.1935	1.875	3.735	.00199 **

Note: M = Mean of the difference in the grade equivalencies of the pre- and post-test scores; *p* = *p*-value for the two-mean t-tests for pre- and post-test scores; * = significant at the 5% level; ** = significant at the 1% level.

Table 25. Regression analysis: effect of training on the grade equivalent academic scores for SLD

Measures	Training B (S.E.)	P	r^2
Reading	0.819 (0.907)	.3740	.0264
Vocabulary	0.656 (0.981)	.5088	.0147
Language	0.0875 (0.937)	.9262	.00029
Mechanics	1.725 (1.091)	.1244	.0769
Math	-0.319 (0.656)	.6308	.0078

Computation	-0.888 (0.719)	.2267	.0483
Science	1.419 (0.678)	.0450*	.1273
Social Studies	.1063 (1.018)	.9176	.00036
Spelling	1.219 (.6960)	.0901	.0927

Note: B = regression coefficient of the training effect on the difference in post- minus pre-test scores; SE = standard error of the regression coefficient; *p* = *p*-value for the significance of the training on the difference in test scores; * = significant at the 5% level.

In response to Research question 2, "What, if any, are the effects of changes in working memory to academic abilities in learners using the *Equipping Minds Cognitive Development Curriculum*?" one must conclude that there were no statistically significant changes to working memory using the *Equipping Minds Cognitive Development Curriculum*, therefore there cannot be correlation between working memory and the statistically significant changes found in the science scores.

Research question 3 asked, "What, if any, is the effect of working memory on non-verbal and verbal abilities?" The findings in Table 23 demonstrate that there was a statistically significant improvement in Verbal test scores for the students in the active control group ($t_{(15)} = 2.979$, $p = .0094$ and the training group ($t_{(15)} = 5.179$, $p = .0001$). The improvement shown by students in the training group on the Non-Verbal test ($t_{(15)} = 6.015$, $p < .0001$) and the IQ Composite ($t_{(15)} = 7.239$, $p < .0001$) was statistically significant, while the improvement shown by students in the active control group was not statistically significant on either the Non-Verbal test or the IQ Composite (see Table 26).

When applying the regression analysis, the findings in Table 24 conclude that the training provided by the *Equipping Minds Cognitive Development Curriculum* made a significant effect on the improvement in test scores for the students for the Verbal (r^2 = .1816, p= .0150) Non-Verbal (r^2 = .2624, p= .0027) and IQ Composite (r^2 = .3927, p= .0001) (see Table 24).

In response to Research question 3, "What, if any, is the effect of working memory on non-verbal and verbal abilities?" one must conclude there were no statistically significant changes to working memory, there cannot be a correlation between working memory and the statistically significant changes found in the verbal, nonverbal and IQ composite scores.

Research question 4 asked, "What, if any, is the effect of the participant's gender on working memory using the *Equipping Minds Cognitive Development Curriculum*?" Research Question 5 asked, "What, if any, is the effect of the participant's age on working memory using the *Equipping Minds Cognitive Development Curriculum*?" An interaction regression model can determine the significance of the training interacting with gender and age on the differences between pre- and post-test scores.

Table 26. Verbal and non-verbal scores for SLD

Measures	**Active Control**			**Training Group**		
	M	$t_{(15)}$	Pre-to-Post (p)	M	$t_{(15)}$	Pre-to-Post (p)

Verbal	5.313	2.979	.00937 **	13.438	5.179	.000112 ***
Non-Verbal	1.125	0.308	.7620	15.813	6.015	.0000237 ***
IQ Composite	1.500	0.580	.5706	16.813	7.239	.00000288 ***

Note: M = Mean of the post- minus pre-test scores; p = p-value for the two-mean t-tests for the difference in pre- and post-test scores; * = significant at the 5% level; ** = significant at the 1% level; *** = significant at the .1% level.

The findings in Table 28 signify that training interacting with gender was not a significant factor in affecting how the students responded to the training provided by the *Equipping Minds Cognitive Development Curriculum*, as evidenced by the improvement shown on the tests in verbal and visuospatial working memory, verbal and non-verbal abilities, and IQ Composite. However, gender did play a significant role in two of the Academic tests: reading (r^2 = .1901, p= .0355) and science (r^2 = .3242, p= .0514). In each of these cases, the improvement in scores was more significant for males in the training group than for females. There were 7 males in the training and the active control group and 9 females in the training and in the active control group.

Table 27. Regression analysis: effect of training on verbal and non-verbal scores for SLD

Measures	Training B (S.E.)	P	r^2
Verbal	8.125 (3.149)	.0150 *	.1816

Non-Verbal	14.688 (4.495)	.00272 **	.2624
IQ Composite	15.313 (3.476)	.000124 ***	.3927

Note: B = regression coefficient of the training effect on the difference in post- minus pre-test scores; SE = standard error of the regression coefficient; *p* = *p*-value for the significance of the training on the difference in test scores; * = significant at the 5% level; ** = significant at the 1% level; *** = significant at the .1% level.

Table 28. Regression output: significance of training interacting with gender and age on scores

Measures	Training: Age B (S.E.)	P	Training: Gender (M)B(S.E)	p	r^2
Verbal WM	5.714 (2.396)	.0247 *	-0.0973 (5.200)	.9852	.1941
Visuospatial WM	-6.604 (4.311)	.1377	8.748 (9.358)	.3585	.2020
Reading	-0.127 (0.903)	.8893	4.345 (1.959)	.0355 *	.1901
Vocabulary	0.805 (1.049)	.4496	-1.613 (2.276)	.4849	.0547

Language	0.206 (0.941)	.8282	3.815 (2.043)	.0731 #	.1526
Mechanics	0.366 (1.117)	.7456	-0.517 (2.424)	.8326	.1877
Math	-0.056 (0.653)	.9318	2.319 (1.418)	.1141	.1744
Computation	-0.281 (0.770)	.7186	0.161 (1.671)	.9240	.0835
Science	-0.552 (0.651)	.4047	2.886 (1.413)	.0514 #	.3242
Social Studies	0.030 (1.056)	.9777	0.787 (2.291)	.7338	.0974
Spelling	0.484 (0.715)	.5046	-2.230 (1.552)	.1626	.1957
Verbal	-3.364 (3.110)	.2893	8.560 (6.322)	.1874	.3660
Non-Verbal	1.229 (4.199)	.7721	-6.607 (8.536)	.4459	.4890
IQ Composite	-4.006 (3.506)	.2636	5.485 (7.128)	.4486	.5094

Note: B = regression coefficient for the interaction of term of Training with Age or with Gender; SE = Standard Error of regression coefficient; *p* = *p*-value for the significance of the interaction term; * = significant at the 5% level.

Thus, in response to Research question 4, "What, if any, is the effect of the participant's gender on working memory using the *Equipping Minds Cognitive Development Curriculum*?" one must conclude there were no statistically significant changes to working memory, there cannot be a correlation between working memory and the participant's gender when using *the Equipping Minds Cognitive Development Curriculum*.

The findings in Table 28 signify that training interacting with age is a significant predictor in the difference in test scores only for the Verbal Working Memory test ($r^2 = .1941$, $p = .0247$). The students ranged from 9 to 14 years of age. More specifically, older students in the training group were more likely to exhibit significant improvement in test scores on the Verbal Working Memory test. Age was not a significant factor in affecting how the students responded to the training provided by the *Equipping Minds Cognitive Development Curriculum*, as exhibited by the improvement of test scores, for any of the other tests.

In response to Research question 5, "What, if any, is the effect of the participant's age on working memory using the *Equipping Minds Cognitive Development Curriculum*?" one must conclude there were no statistically significant changes to working memory, there cannot be a correlation between working memory and the participant's age.

Table 29. Group profiles and means for pre and post training assessments

	Active Control Group	Training Group

Measures	Pre-Test M (S.E.)	Post-Test M (S.E.)	Pre-To-Post p	Pre-Test M (S.E.)	Post-Test M (S.E.)	Pre-To-Post p
Verbal WM	93.88 (8.55)	96.00 (10.30)	.2671	88.31 (11.94)	92.19 (11.50)	.0265
Visuospatial WM	101.31 (15.12)	100.25 (15.73)	.7480	93.69 (15.81)	98.00 (15.99)	.1495
Verbal Short Term Memory	94.31 (11.25)	96.75 (11.43)	.4342	89.31 (11.31)	92.50 (14.76)	.1188
Visuospatial Short Term Memory	104.50 (19.17)	101.25 (17.81)	.3542	103.13 (14.60)	104.25 (13.14)	.7224
Reading	6.156 (2.489)	6.406 (2.641)	.7508	4.131 (0.980)	5.200 (1.904)	.0399
Vocabulary	6.988 (2.496)	7.138 (2.253)	.8411	5.044 (1.663)	5.850 (2.132)	.2336
Language	6.494 (2.760)	7.575 (2.460)	.1148	4.525 (1.055)	5.694 (2.575)	.1055
Mechanics	6.038 (3.096)	5.444 (1.982)	.4624	4.500 (2.260)	5.631 (3.091)	.1549
Math	5.094 (1.912)	5.913 (2.198)	.1256	4.275 (0.904)	4.775 (2.050)	.2521
Computation	5.581 (1.843)	6.356 (2.716)	.1679	4.556 (1.301)	4.444 (1.352)	.8181
Science	6.444 (2.179)	6.463 (1.810)	.9745	4.700 (1.726)	6.138 (1.810)	.00105
Social Studies	6.081 (2.196)	6.925 (2.349)	.2268	4.763 (2.852)	5.713 (2.378)	.2345
Spelling	5.175 (2.037)	5.831 (2.178)	.1935	4.038 (1.527)	5.913	.00199

					(2.459)	
Verbal	**101.25 (10.38)**	**104.19 (13.49)**	**.00937**	**94.56 (10.51)**	**108.00 (15.99)**	**.000112**
Non-Verbal	**104.69 (10.62)**	**104.19 (13.76)**	**.7620**	**100.81 (10.17)**	**116.00 (10.77)**	**.0000237**
IQ Composite	**103.69 (8.55)**	**105.06 (12.35)**	**.5706**	**97.13 (9.84)**	**113.94 (14.08)**	**.00000288**

Discussion

Guided by the five research questions, the following list is a summary of the implications derived from the researcher's evaluation of the analysis of the findings:

1. Students with SLD have low working memory scores which impact academic performance (see research question 1).
2. Working memory training does not seem to have a causative effect in relationship to verbal, nonverbal, and academic abilities when using *EMCDC* for 30 hours of intervention (see research question 1).
3. Thirty hours of intervention with *EMCDC* significantly improves science scores demonstrating far transfer effects in learners with a SLD (see research question 2 and Table 29).
4. *EMCDC* increases cognitive abilities of verbal (13 points), nonverbal (15 points), and IQ composite (16 points) despite insignificant measurable changes in working memory (see research question 3 and Table 29).

5. Human-mediated learning using a cognitive development curriculum, *EMCDC*, increases cognitive abilities of verbal, nonverbal, and IQ composite scores in learners with a SLD (see research question 3).
6. Gender is not a significant factor in a student's response to the training provided by *EMCDC* in verbal and visuospatial working memory, verbal and non-verbal abilities, and IQ Composite (see research question 4).
7. *EMCDC* impacts males more significantly than females in reading and science (see research question 4).
8. Older students are more likely to exhibit significant improvement in test scores on the Verbal Working Memory test (see research question 5).

The first research question examined the effects on working memory when applying the *EMCDC*. The implication suggested by research over the last twenty years is that children with a SLD have low working memory (WM) which impacts academic performance. To determine the participants working memory scores, the *AWMA*-2 was the assessment used for both pre-test and post-test scores for working memory. The verbal working memory scores for the pre- and post-testing for participants in the training group was statistically significant ($t_{(15)} = 2.459$, $p = .0265$) and while the active control group made gains in verbal working memory, the change was not statistically significant. In regard to the visuospatial working memory pre- and post-testing, the training group continued to make gains, but the active control group decreased. However, the regression analysis demonstrated it is not possible to conclude that the training provided by *EMCDC* had a significant effect on the participants in verbal or visuospatial working memory in the 30 hours of intervention during a 7-week period. Therefore, the implication from the present research is that working memory training does not have a causative effect in relationship to verbal, nonverbal, and academic abilities when using *EMCDC*.

In response to the second research question, having found that working memory did not significantly increase, significant gains were not expected in academic abilities. However, this assumption was incorrect. The results demonstrated that there was a statistically significant improvement in the reading ($t_{(15)} = 2.249$, $p = .0399$) science ($t_{(15)} = 4.050$, $p = .0010$) and spelling ($t_{(15)} = 3.735$, $p = .0019$) test scores for the students in the training group without significant gains in working memory. Students in the training group showed improvement on each academic test aside from computation, but the other improvements were not statistically significant. There was no statistically significant improvement on any of the academic tests in the active control group which received 30 hours of additional academic training.

The regression analysis reveals that the training provided by the *Equipping Minds Cognitive Development Curriculum* made a statistically significant improvement in test scores for the students on the science test ($r^2 = .1273$, $p = .0450$) and tend toward statistical significance on the spelling test ($r^2 = .0927$, $p = .0901$).

It is important to note that the annual academic assessment with *TerraNova* had been given in April of 2015 and April of 2016. The participants in the study had attended the same school for students with learning challenges for a minimum of two years. The teachers and interventionists at the participants' school are trained in numerous reading, mathematics, language, science, and spelling curricula designed for students with learning challenges. The participants in the training and active control group had received identical academic instruction for the entire school year. While the training group had participated in the study from February 2016-April 2016, *EMCDC* is void of academic content. While the findings were not statistically significant for language and reading, the training group did make stronger gains in these areas than the active control group. This implies that thirty hours of intervention with *EMCDC* significantly improves science scores demonstrating far transfer effects in learners with a SLD.

Having found that working memory did not significantly increase, significant gains in verbal and nonverbal abilities and IQ composite were not expected. The literature on working memory training with computerized cognitive training shows minimal transfer to verbal and nonverbal abilities even when gains in working memory are significant (Melby-Hulme 2013). In response to the third research question, the findings have implications to a question that was not being asked: "Can IQ be increased in learners with a SLD using *EMCDC* independent of gains in working memory?" There was a statistically significant improvement in verbal test scores for the students in the active control group ($t_{(15)} = 2.979$, $p = .0094$) and the training group ($t_{(15)} = 5.179$, $p = .0001$). Applying the regression output, the improvement shown by students in the training group on the non-verbal test and the IQ composite was extremely statistically significant, with $p < .0001$ and $< .0001$, respectively, while the improvement shown by students in the active control group was not statistically significant on the non-verbal test nor on the IQ composite. The research concludes, and the findings support, that the training provided by the *Equipping Minds Cognitive Development Curriculum* makes a significant effect on the improvement in test scores for the students in verbal (r^2 =.1816, p = .0150), non-verbal (r^2 =.2624, p = .0027), and IQ (r^2 =.3927, $p <$ .0001). This implies that *EMCDC* increases verbal abilities, nonverbal abilities, and IQ composite despite insignificant measurable changes in working memory.

The results of the research support a holistic approach with *EMCDC* by training cognitive functions and the cognitive skills of working memory, processing, comprehension, and reasoning abilities to increase verbal abilities, nonverbal abilities, IQ composite, and academics. This implies human-mediated learning using a cognitive development curriculum, such as *EMCDC*, increases cognitive abilities of verbal, nonverbal, and IQ composite scores in learners with a SLD.

The fourth research question examined whether a participants' gender impacted working memory, when using the *EMCDC*. The findings indicate that gender was not a significant factor in how the students responded to the training provided by the *Equipping Minds Cognitive Development Curriculum*, as evidenced by the improvement shown on the tests in verbal and visuospatial working memory, verbal and non-verbal abilities, and IQ composite. However, gender did play a significant role in two of the academic tests: reading (r^2 = .1901, p= .0355) and science (r^2 = .3242, p= .0514). In each of these cases, the improvement in scores was more significant for males in the training group than for females. There were seven males in the training and the active control group and nine females in the training and in the active control group. These findings imply *EMCDC* impacts males more significantly than females in reading, language, and science.

The fifth research question examined how a learner's age influenced working memory when using the *EMCDC*. The findings signify that training interacting with age is a significant predictor in the difference in test scores only for the verbal Working Memory test (r^2 = .1941, *p* = .0247). The students ranged from 9 to 14 years of age. More specifically, the findings imply older students are more likely to exhibit significant improvement in test scores on the verbal Working Memory test. Age was not a significant factor in affecting how the students responded to the training provided by the *Equipping Minds Cognitive Development Curriculum*, as exhibited by the improvement of test scores for any of the other tests.

Conclusion

Additionally, the study demonstrated that it is possible to use *EMCDC* to raise the cognitive abilities of learners to an extent that has previously not been linked to learners with these disorders in 30 hours over seven weeks. The current research found that training in working memory, processing, comprehension, and fluid reasoning with a holistic approach does provide convincing evidence to the generalization of verbal abilities (13 points), nonverbal abilities (15 points), and IQ composite (16 points). Similarly, far transfer effects to academic abilities in science were substantiated.

Lessons Learned: Reasons for Implementing Cognitive Training

Finally, the existing research demonstrates the effectiveness of cognitive training to increase cognitive skills in the verbal and nonverbal reasoning realm. The implications for educators and psychologists are substantial since cognitive skills, intelligence, and academics can be developed when a mediator teaches and trains students of all ages and abilities. School administrators, teachers, and parents should be educated on the theory of structural cognitive modifiability and how to be an effective mediator of the environment without over-stimulating the child. Educators need to be trained in mediated learning and the Equipping Minds Cognitive Development Curriculum. A combination of cognitive training and curricular studies should result in significant advancement of both cognitive and domain-specific skills of all students.

Cognitive skills are the key to learning, social and emotional skills, attention, self-regulation, and decision making. When students move from frustration in the classroom to success, in turn, negative behavior incidents decrease. As student's processing, memory, and problem-solving skills increase, their attention, self- regulation, and decision making will improve as well. A cognitive training program can improve academic skills which should reduce the dropout rate and delinquent classroom behaviors hence, providing a safer and successful learning environment for all students.

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