

## Computer training or human mediator

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### Abstract

In recent years the majority of research studies in peer reviewed journals have utilized computer software programs to enhance cognitive skills with a focus on working memory training. An alternative approach absent in the current literature on working memory training is the use of a human mediator. Mediation is an interaction in which a human mediator who possesses knowledge intends to convey a particular meaning or skill and encourages the child to transcend, that is, to relate the meaning to some other thought or experience. Mediation is intended to help children expand their cognitive capacity, especially when ideas are new or challenging. The *Equipping Minds Cognitive Development Curriculum (EMCDC)* is a method of cognitive skill development which uses a human mediator and is based on the theory of Structural Cognitive Modifiability (SCM), Mediated Learning Experience (MLE), and a biblical worldview of human development. The success of the research with *EMCDC* supports the use of a human mediator, which is rooted in Scripture and Feuerstein's theory of Mediated Learning Experience (MLE), and affirms that cognitive skills can be developed in the classroom or clinical setting through a human mediator rather than a computer program.

**Keywords:** Computer training, cognitive development, Feuerstein, Equipping Minds, mediated learning, working memory, Specific Learning Disorders

### Introduction

In recent years the majority of research studies in peer reviewed journals have utilized computer software programs to enhance cognitive skills. An alternative approach absent in the current literature on cognitive development is the use of a human mediator. While the use of technology in the classroom is prolific, it is impersonal and has not been proven to be more effective than a human mediator. Hulme and Melby-Lervag (1) evaluated the claims of computer-based cognitive skill programs in a systematic meta-analysis review of the existing studies and they concluded:

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Our meta-analyses show clearly that these training programs give only near-transfer effects, and there is no convincing evidence that even such near-transfer effects are durable. The absence of transfer to tasks that are unlike the training tasks shows that there is no evidence these programs are suitable as methods of treatment for children with developmental cognitive disorders or as ways of effecting general improvements in adults' or children's cognitive skills or scholastic attainments (1).

### *Proposed origin and purpose of structural cognitive modifiability*

However, the Feuerstein Institute has conducted research with “Feuerstein Instrumental Enrichment” (FIE) that confirms cognitive abilities can be modified demonstrating far transfer effects and generalized to academics for many years (2). The first program to increase intellectual performance for those with neurodevelopmental learning disorders was developed more than fifty years ago by Reuven Feuerstein (1921-2014), a clinical and cognitive psychologist who studied under Jean Piaget and Andre Ray in Geneva (3). Piaget's theory stated that a person's intelligence was not only fixed, but that it developed in predictable stages at predetermined times with each stage needing to be mastered before moving to the next (4). Educators, psychologists, and school counselors embraced Piaget's view (5). Feuerstein, on the other hand, believed that intelligence was changeable and modifiable regardless of age, neurodevelopmental conditions, genetics, and developmental disabilities (3). He also disagreed with the accepted concept of the *critical period* or *critical age*, which states that if a person has not reached a particular function by a certain age, he or she no longer has the ability to learn that skill. For example, while approximately seven years of age is the critical period for learning to speak, Feuerstein had a child who did not learn to speak until the age of nine and eventually learned to read and write (3). According to Brian Boyd, “Feuerstein believed that when someone presents himself or herself as unable to understand something, one does not make the assumption that he or she is unintelligent. Rather, it is assumed that the person's intelligence is lying dormant, and the process of mediation by a teacher allows that intelligence—

that latent intelligence—to come to the surface” (6). Feuerstein's theory is known as structural cognitive modifiability (SCM). His theory of human development has three basic ideas:

- Three forces shape human beings: environment, human biology, and mediation.
- Temporary states determine behavior: How someone behaves—namely emotional, intellectual, and even habitually learned activities—represents a temporary state, not a permanent trait. This means that intelligence is adaptive. In other words, intelligence can change; it is not fixed once and for all.
- The brain is plastic: because all behaviors are open and developing, the brain can generate new structures through a combination of external and internal factors (7).

Feuerstein insisted that human cognitive abilities can be changed regardless of heredity, genetic disorder, chromosomal disorders, or a person's age, even if the neuro-developmental condition is generally considered irrevocable and irreparable. “Don't tell me what a person is,” said Feuerstein. “Tell me how he is changeable (8)!”

### *Mediated learning*

The theory of Mediated Learning Experience (MLE) initially grew as part of Feuerstein's theory of Structural Cognitive Modifiability (SCM) (8). Mediation is an interaction in which a mediator who possesses knowledge intends to convey a particular meaning or skill and encourages the child to transcend, that is, to relate the meaning to some other thought or experience. Mediation is intended to help children expand their cognitive capacity, especially when ideas are new or challenging.

MLE is a way of interaction which contrasts with Piaget's view. Piaget advocated for a natural progression of learning through direct exposure to stimuli, or the “stimulus-organism-response (S-O-R)” model, which holds that it is enough for a person to simply dialogue with nature and the environment for cognitive development to occur (9). Piaget is correct in saying that when you explore on your own, a

natural progression leads to a natural limitation. Feuerstein believes a human mediator is needed, or “stimulus-human-organism-human-response (S-H-O-H-R),” allowing the mediator to take the learner beyond the natural limitations to reaching his or her full cognitive potential. While Piaget and Feuerstein are both giants in the field of human development, their greatest differences are their beliefs in fixed versus changeable intelligence and the role of a human mediator in developing a child’s intelligence (3). Piaget did not believe that adults are any different from other objects that provide information, and thus they should not intervene in a child’s activity. He believed in spontaneous development: “I will call it psychological—the development of the intelligence itself, what the child learns by himself, what none can teach him, and what he must discover alone” (4). Feuerstein, however, sees the human mediator as crucial for a learner’s development (3).

Educators who embraced Piaget’s direct approach to learning believed that mediation is unnecessary and interferes with a learner’s independence and sense of freedom (3). These educators believe many learners with neurodevelopmental learning disorders (NLD) are unmodifiable (10). However, educators who implement mediation into their teaching realize that students with NLD can learn and are modifiable (9). The theory of Structural Cognitive Modifiability (SCM), using the Mediated Learning Experience (MLE) method and its practical application, the Instrumental Enrichment (IE) program, has been used in numerous research studies in different countries to increase the cognitive abilities of learners with neurodevelopmental learning disorders (11-13).

The *Equipping Minds Cognitive Development Curriculum (EMCDC)* is a method of cognitive skill development which uses a human mediator and is based on the theory of Structural Cognitive Modifiability (SCM), Mediated Learning Experience (MLE), and a biblical worldview of human development. The success of the research with *EMCDC* supports the use of a human mediator, which is rooted in Scripture and Feuerstein’s theory of Mediated Learning Experience (MLE), and affirms that cognitive skills can be developed in the classroom or clinical setting through a human mediator rather than a computer program (11-13).

### *Computer training program to increase working memory*

Several computer-based working memory training programs have been developed since 2000. *Cogmed Working Memory Training* is used in over 30 countries in the clinic and classroom setting. It was originally developed to improve working memory in learners with attention deficit disorder (ADHD) (11-13). Klingberg and associates showed an increase in working memory abilities for children with ADHD and adults without ADHD. The participants were measured by the Stroop test, working memory test, and the Raven’s Progressive Matrix (14). Since the initial study, numerous research studies have been completed showing improvements in working memory (15). *Cogmed* recommends training for 30–45 minutes a day for five weeks, according to Melby-Lervag and Hulme (1).

Another computer-based, working-memory training program developed by Ross Alloway is *Jungle Memory*. The program reports to increase academic scores in children with ADHD and other learning disorders. The program targets children between seven to sixteen years of age with a commitment of eight weeks (17). In a recent study by Alloway, Bibile, and Lau, three groups were tested on measures of working memory, verbal and nonverbal ability, and academic attainment before training; also, the groups were re-tested on the same measures after training, as well as eight months later. The data indicate gains in both verbal and visuospatial, working-memory tasks for the high-frequency training group. Improvements were also evidenced in tests of verbal and nonverbal ability tests, as well as spelling, in the high-frequency training group (18).

### *Cognitive development programs using human mediators*

An approach missing from the reviews on working memory and cognitive skill training are programs that do not utilize a computer-based program but a human mediator. Within those studies using computer-based programs, the cognitive enhancement of learners with severe NLD receives inadequate attention (11).

### *Bright start*

Research on the impact of cognitive development programs of children with developmental disabilities, such as Down syndrome and other genetic syndromes, intellectual disabilities, and cerebral palsy is limited (11). Yet the research that has been done substantiates that learners with intellectual disorders can participate and benefit from cognitive development and enrichment programs. The “Bright start” program of Brooks and Haywood, which is based on Feuerstein’s theories, increases intelligence quotient (IQ), enhances logical reasoning and problem-solving skills, allows children to be included in the regular classroom, and increases academic performance and intrinsic motivation (19). Klauer’s inductive reasoning program and Paour’s “transformation box” program have demonstrated the ability of learners with intellectual disorders to move beyond the pre-operational level of thinking (20-21).

### *Philosophy for children program*

Haywood comes from a psychological perspective, whereas the next program, which seeks to enhance children’s cognitive functioning, comes from a philosopher, Matthew Lipman. His philosophy for children program examines the classroom community of inquiry and the use of story texts to stimulate thinking. Like Feuerstein, Lipman placed a significant role on the adult mediator to enable children to reach higher levels of cognitive abilities (22). His program is a meditational tool in which the aim is “not to turn children into philosophers or decision-makers, but to help them become more thoughtful, more reflective, more considerate, more reasonable individuals” (23).

### *Reuven Feuerstein: Pioneer of neuroplasticity*

The first program to increase intellectual performance with learners with neurodevelopmental learning disorders was developed more than fifty years ago by Reuven Feuerstein, clinical and cognitive psychologist who believed that intelligence was changeable and modifiable regardless of age, genetics, neurodevelopmental conditions, and

developmental disabilities (3). Feuerstein worked with a wide range of different groups of people—from Holocaust survivors to people who had suffered from brain damage, Down syndrome, and autism, to those who are intellectually gifted. When he began working with the children who had survived the Holocaust, the goal was to rehabilitate them from their traumatic experiences. He asked himself, “How will I be able to speak to them tomorrow morning about what they had learned, or about Bible chapters, or about any other study subject? The question that bothered me most of all was: Were these children capable of change after all they had been through” (3)?

“Belief in modifiability” is an essential element of Feuerstein’s theory of structural cognitive modifiability (3). According to Kozulin, who is the academic coordinator of the international department at the Feuerstein Institute, Feuerstein was often criticized for deliberately including a “belief system” into his theory, because according to the critics there is no place for “beliefs” in scientifically based programs (24). In *Changing minds and brains*, Feuerstein states, “I have come to believe that spiritual thinking and behavior produces changes in the gray matter of the brain (9).” Christian educators agree that our faith consists of belief and trust, and also impacts who we are (25).

Reuven Feuerstein was born in the village of Botosani, Romania, in 1921. He was raised in a devout orthodox Jewish family, as previously mentioned; he studied the Bible throughout his life, and credited the daily discussions of Scripture with his father with developing his cognitive abilities (8). To reiterate his theistic worldview, he stated, “The individual is asked to act in the image of [God] as is stated: [God] made man in his image” (26).

Feuerstein studied at the University of Geneva, completing degrees in general and clinical psychology (in 1952) and obtained a license in psychology (in 1954). In 1970 he earned his PhD in developmental psychology at the Sorbonne where his major areas of study were developmental, clinical, and cognitive psychology from a cross-cultural perspective. He served as professor of educational psychology in Bar Ilan University School of Education in Israel and as an adjunct professor at Vanderbilt University’s Peabody College of Education. He was the chairman

of the International Center for the Enhancement of Learning Potential (ICELP) in Jerusalem until his death in 2014. The primary focus of the ICELP and his life's work has been the development of the theories of Structural Cognitive Modifiability (SCM), Mediated Learning Experience (MLE), the Learning Propensity Assessment Device (LPAD), which is a dynamic assessment, and the Instrumental Enrichment [IE] basic and standard programs, an active intervention to modify cognitive structures.

### *Instrumental enrichment*

The theory of SCM and the applications of MLE are the foundation of Feuerstein's instrumental enrichment (FIE) standard and basic programs that were developed over forty years ago. FIE Standard is a cognitive development program emphasizing critical thinking strategies. The FIE Standard program contains fourteen instruments designed to build the prerequisites and processes of learning rather than academic content or skills. The FIE Basic program has been designed for learners 3–8 years of age who have learning challenges. FIE Basic complements the FIE Standard version and has eleven instruments. They can be implemented in a classroom or as a therapeutic intervention in a small group or an individualized basis. FIE initially focused on culturally deprived and low-functioning children and adolescents with chromosomally-determined conditions to build their cognitive functions and structures. The program has expanded to include learners of all ages and abilities to strengthen their learning capacity (7).

### *Research studies on cognitive enhancement*

The Feuerstein Institute has conducted research that confirms cognitive abilities can be modified (2). Instrumental Enrichment (FIE) and MLE have been found to enhance cognitive abilities of learners with neurodevelopmental learning disorders (11). Many of these learners also have cultural deprivation and differences. These studies have encompassed many types of student populations using FIE (7). Studies in the following areas are discussed, including attention

deficit disorders, autism, and developmental disabilities.

### *Attention deficit disorders*

In regard to learners with attention deficit disorder (ADD), Krieger and Kaplan found a significant increase in reading accuracy and comprehension (27). Roth and Szamoskozi found students with ADHD increase their precision, their written expression of ideas on paper, their ability to find relevant cues in problem-solving situations, and their declarative knowledge (28).

### *Autism*

Research in the field of autism continues to develop. The research staff at ICELP are reviewing all of the studies that use Feuerstein Instrumental Enrichment (FIE). A study in Canada with twenty autistic learners who used FIE indicates a high level of success using MLE, and the results were reported at several international conferences (29). Gross and Stevens demonstrated improvements in visual attention and tracking, following directions, understanding cause and effect, turn taking, making choices, and predication and persistence (30).

### *Specific learning disabilities*

IE approaches were found to impact reading scores in sixth grade students who were reading two years below grade level in remedial classes in Westchester County, New York (31). In a three-year study with students who had deficient language skills a significant increase was found in oral and written language, vocabulary, and grammar (32).

### *Neurodevelopmental disabilities*

Kozulin and colleagues conducted a study 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. These are then 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 (11).

In 2014, Krisztina Bohács studied learners from two to fourteen years of age with mild to moderate intellectual developmental disorders, including genetic syndromes, cerebral palsy, ADHD, and autism. The Raven Colored Matrices showed an increase in general intelligence, and there were significant changes in cognitive development. There was also growth in domains necessary for school readiness. Bohács states, "If applied systematically with children with intellectual disabilities for a longer period of time (maybe even for 3-4 years) the applied systems are expected to lead to increased learning effectiveness, more effective basic cognitive processes and thinking skills, and to prepare children for school learning and a better adaptation to the challenges of everyday life" (33).

#### *Four-year case study with Equipping Minds Cognitive Development Curriculum*

Bohács recommended a three to four-year study with learners who have NLD. An individual case study was done with the *Equipping Minds Cognitive Development Curriculum (EMCDC)* (18) from 2011-2015 with a learner with a NLD, namely Down syndrome (34-35). In September 2011, Marie's parents contacted Brown to discuss using *EMCDC* to strengthen Marie's cognitive abilities; visual and auditory processing speed, comprehension, working memory, long term memory, and reasoning skills. According to her parents, despite all the support from Marie's teachers, occupational therapist, speech therapist, special education teacher, and principal in third grade, her Measures of Academic Progress (MAP) scores—yearly academic tests that measure student growth from semester to semester—stayed stagnant for a full year. In the fall semester of her

fourth grade year the first MAP scores again showed no growth. Brown reviewed the academic and psychological testing showing an intellectual disability with deficits in processing, working memory, comprehension, and perceptual reasoning; she then agreed to begin working with Marie using *EMCDC*.

With the support of the school system, Brown worked with Marie an hour of every school day for the next twelve weeks. At the end of nine weeks, the principal enthusiastically reported that Marie had increased 20 points in reading, 11 points in math, 25 points in science, and 17 points in language arts. These gains were unprecedented, as students typically increase 3–5 points.

Until this time, Marie had made minimal progress and her academic test scores had remained static from third to fourth grade. The change in these scores had been achieved over the nine-week period through one-on-one cognitive developmental exercises for enhancing processing, working memory, comprehension, and reasoning; this was divorced from academic content. Previously, she had received the standard interventions, which included remediation of content, learning strategies, and accommodations. These may have short-term benefits, but were not targeting the underlying cognitive deficits in processing and working memory, which would increase her cognitive abilities.

Marie's progress is significant for those who still believe that measurable intelligence is due primarily to nature or one's genetic factors, and only minimally due to nurture or environmental factors which holds to a limited potential for change (36). Since Marie has an intellectual disability and Down syndrome, many educators believe these disorders limit her ability for significant academic gains. Educator, Carolyn Mervis, stated that in her research with students with Down Syndrome, she was not aware of any case where cognitive developmental exercises had generalized to academics in a nine-week period. Mervis performed a full cognitive assessment on Marie. She stated that the gains in processing and working memory were greater than she had ever seen (41). Marie and seven other students with Down Syndrome were asked to participate in a three-year pilot study with *EMCDC* with the University of Louisville Department of Psychological and Brain Sciences in the summer of

2011. The pilot study was not completed according to a correspondence with Mervis due to other research commitments within the department (42). However, Marie's improvement implies that cognitive developmental exercises do have far transfer effects to academic achievement for learners who have an intellectual developmental disorder. Below are the results of the MAP tests after that first nine weeks,

and over the next four years. Figures 1-4 illustrate recreations of the MAP test results which demonstrate significant gains in academic abilities. It should be noted that while Marie has Down syndrome, the only accommodations she received on MAP testing was extended time and having a reader for math, science, and language. She read the reading assessments herself. See figures below.

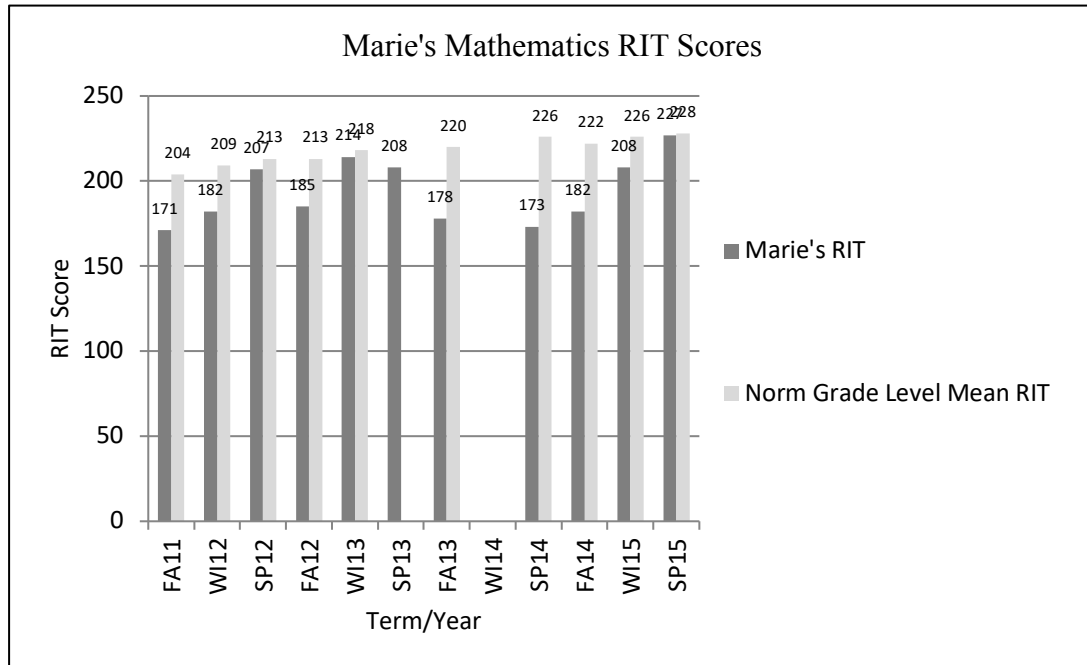


Figure 1. Marie's mathematics RIT scores.

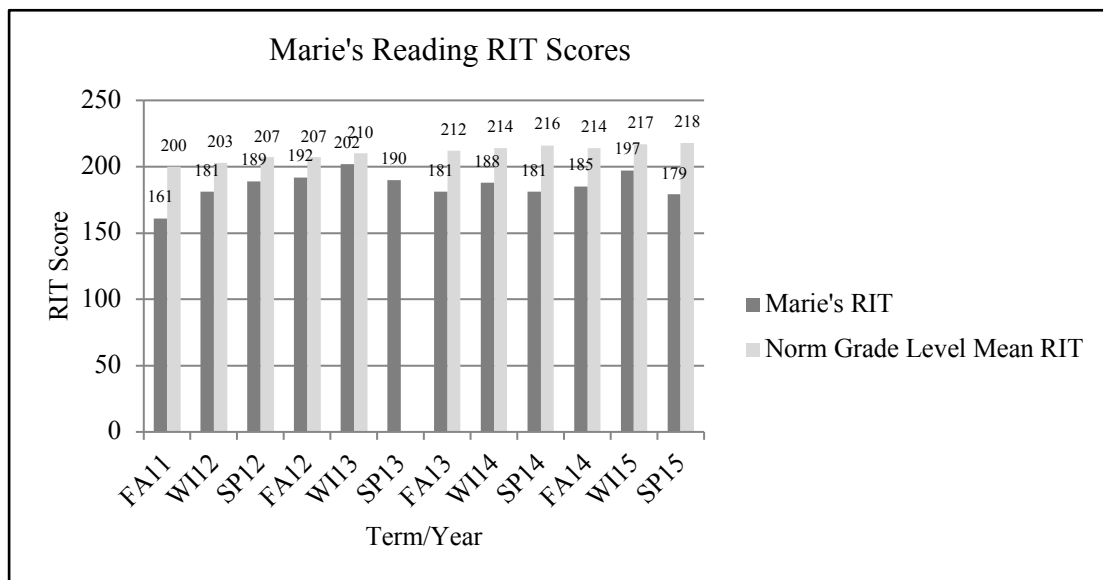


Figure 2. Marie's reading RIT scores.

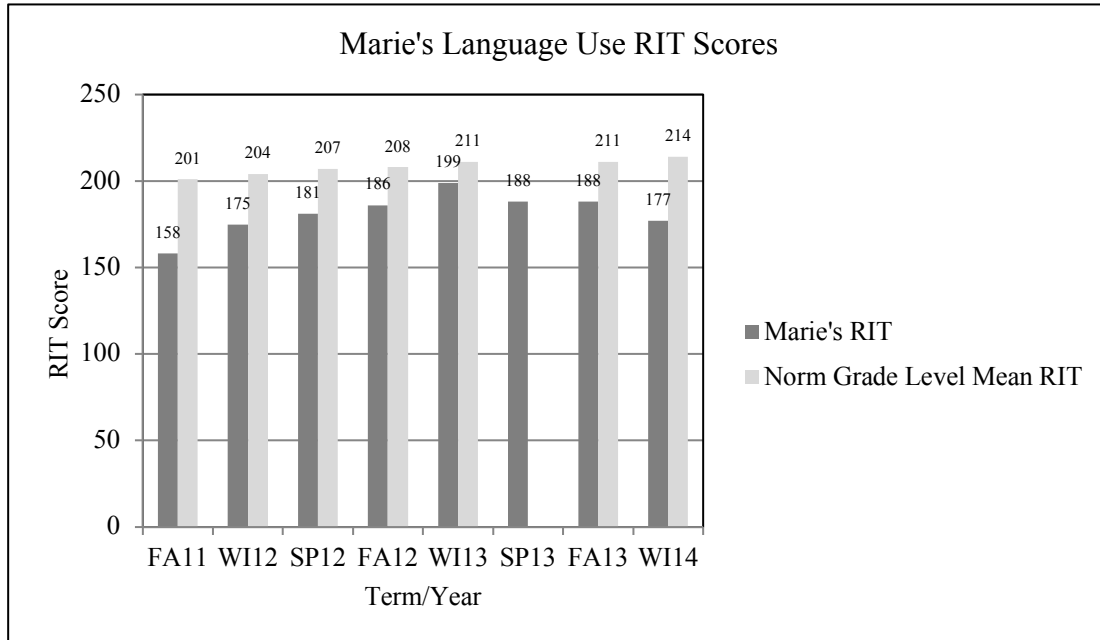


Figure 3. Marie's language RIT scores

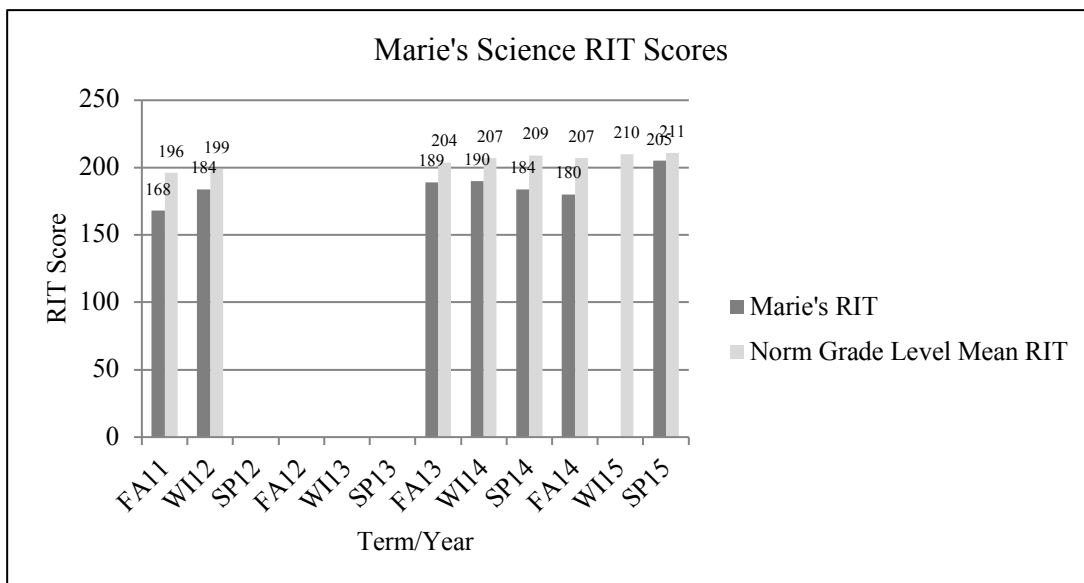


Figure 4. Marie's science RIT scores.

Marie would continue the cognitive developmental exercises and continue to progress academically for the next four years. Re-creations of her Kentucky Performance Rating for Educational (KPREP) scores are illustrated on Figures 5-7 showing 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 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. 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 8

illustrates a re-creation of the SCP for sixth and seventh grade. In 2015, as a seventh grader, she scored in the 39<sup>th</sup> percentile in mathematics, 36<sup>th</sup> percentile in science, and the 7<sup>th</sup> percentile in reading on the Stanford Ten National Assessment Ranking. Figure 9 illustrates a re-creation of the Stanford National Ranking.

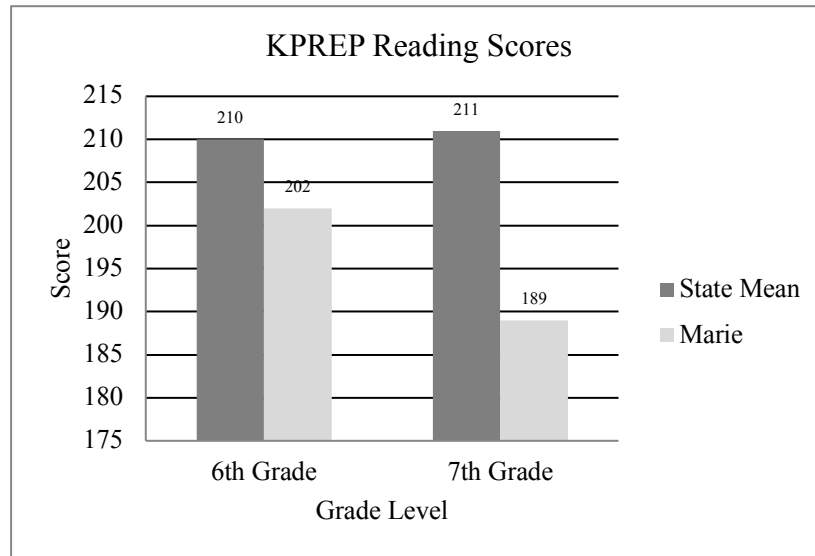


Figure 5. KPREP reading scores.

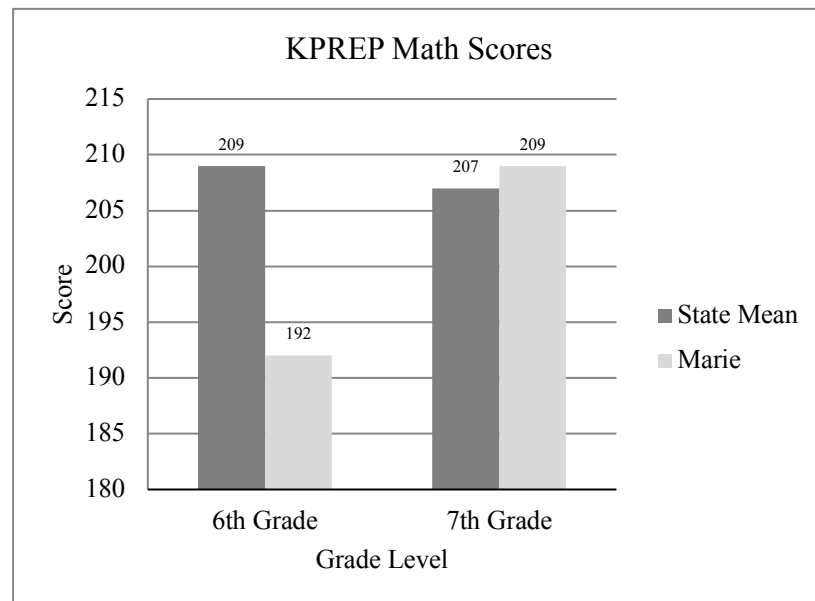


Figure 6. KPREP math scores.

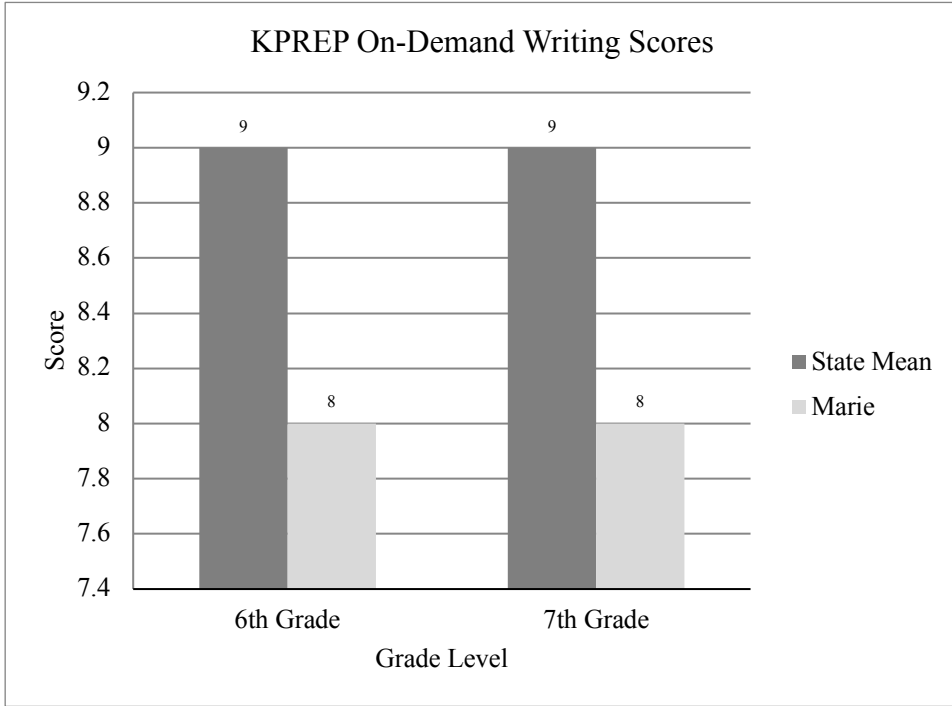


Figure 7. KPREP on-demand writing scores.

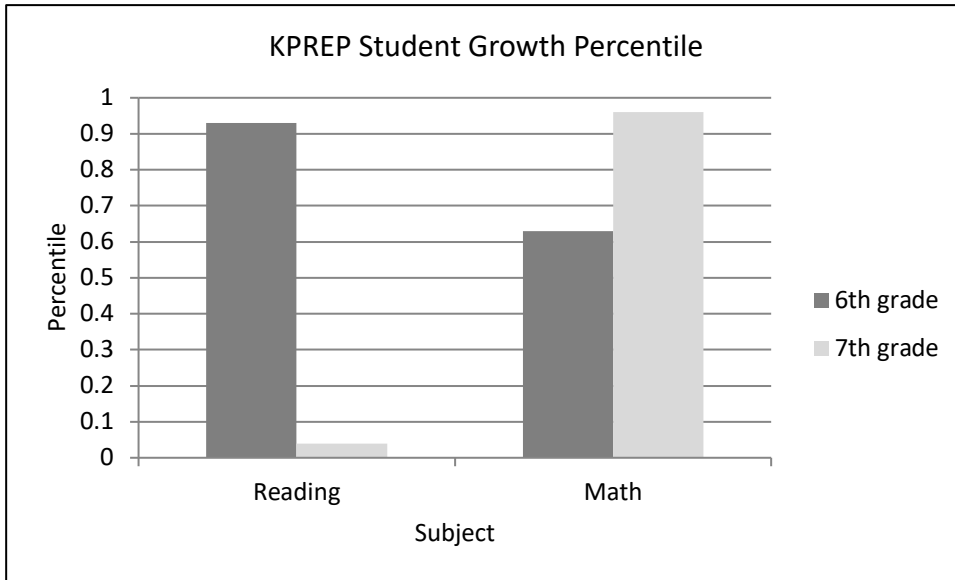


Figure 8. KPREP student growth percentile.

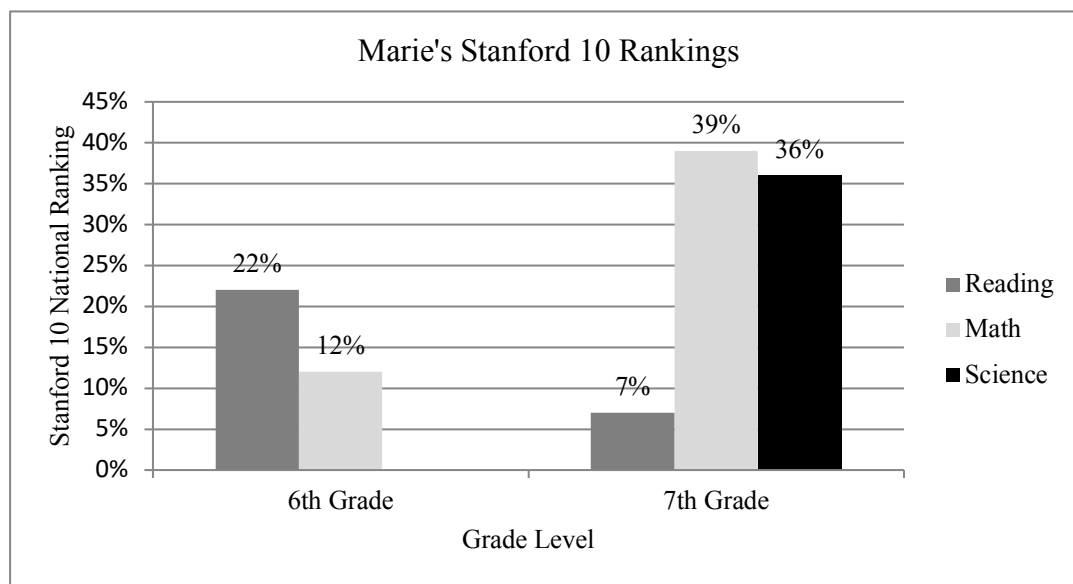


Figure 9. Marie's Stanford 10 rankings.

## Discussion

The implications for public, private, and religious school practitioners, higher education practitioners, academicians and professionals, homeschool parents, adoption and foster care parents, and missionaries are substantial since intelligence can be developed when a mediator teaches and trains a learner. The author of this study, Carol T. Brown, conducted professional development workshops for each of these groups who express appreciation for the training in cognitive development, as this is a void in teacher education programs. With this in mind, consider the following:

1. This study may benefit local church leaders by providing educational materials and resources for developing a special-needs ministry in the church and providing an after school or summer program for children and adults to integrate spiritual formation and cognitive formation. There are approximately 54 million people in the U.S. that are affected by disability, with estimates of 80 percent who are unreached and do not attend a church. Yet, less than 10 percent of the churches in the U.S. have an intentional disability ministry or outreach (37).
2. This study may benefit private and religious school practitioners to understand the benefit of mediated learning and cognitive developmental exercises. A combination of cognitive developmental exercises and curricular studies should result in significant advancement of both cognitive and domain-specific skills for all learners. The private and religious school will no longer need to refer parents to public schools but will be able to include more students with NLD in the private and religious school setting.
3. This study may benefit higher education administrators, practitioners, and student service professionals who serve and teach students with NLD and those with undiagnosed learning struggles. Addressing the underlying deficits in working memory may increase student's academic satisfaction increasing student retention and graduation rates. As the number of adult learners is increasing in higher education, it is important to continue to engage in stimulating learning activities during adulthood to manage the demands on working memory.
4. This study may benefit Teacher Education Programs for the course Teaching Exceptional Learners.

5. This study may benefit academicians and professionals in the fields of education, cognitive psychology, educational psychology, child and adolescent psychiatry, human development, social work, occupational therapy, and speech-language pathology who work with learners with NLD.
6. This study may benefit homeschool parents. In 2013, the U.S. Department of Education's National Center for Education Statistics reported that approximately 1,770,000 students are homeschooled in the United States—3.4 percent of the school-age population. Among children who were homeschooled, 68 percent are white, 15 percent are Hispanic, 8 percent are black, and 4 percent are Asian or Pacific Islander (38). The Home School Legal Defense Association has over 14,000 families who subscribe to the struggling learners newsletter (39).
7. This study may benefit missionaries serving abroad and stateside who have children with NLD and desire to stay on the mission field. Many missionaries homeschool or place their children in schools in the country where they serve. There are limited services for children with NLD in many countries. A cognitive curriculum which parents can implement at home would allow them to continue fulfilling their calling and develop their child's cognitive abilities. Missionaries will also be equipped to help other learners with NLD where they serve.
8. This study may benefit parents who have adopted or foster children with special needs and NLD. According to Karen Purvis, adopted and foster children can bring many challenges with them, including abandonment issues, neurological alternations, cognitive impairments, sensory processing deficits, and other struggles (40). Adopted and foster children need guidance in learning to relate to others. Parents are encouraged to intentionally interact with their child (40).

## Conclusion

The success of the research with Feuerstein's Instrumental Enrichment program based on the theory of SCM and implementation of MLE affirms that cognitive skills can be developed in the classroom or clinical setting through a human mediator (11).

The *Equipping Minds Cognitive Development Curriculum (EMCDC)* is a method of cognitive skill development which uses a human mediator and is based on the theory of Structural Cognitive Modifiability (SCM), Mediated Learning Experience (MLE), and a biblical worldview of human development. The success of the research with *EMCDC* supports the use of a human mediator, which is rooted in Scripture and Feuerstein's theory of Mediated Learning Experience (MLE), and affirms that cognitive skills can be developed in the classroom or clinical setting through a human mediator rather than a computer program (11).

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