EDUCATIONAL DIAGNOSTICIANS' PERCEPTIONS ON THE LINK BETWEEN CHC THEORY AND RECOMMENDATIONS OF INSTRUCTIONAL INTERVENTIONS AND ACCOMMODATIONS

A DISSERTATION

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To the Dean of the Graduate School:

I am submitting herewith a dissertation written by Carla Jene Mackey Proctor entitled "Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations." I have examined this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a major in Special Education.

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DEDICATION

This dissertation is dedicated in memory of Margaret Ann Proctor, whose caring wisdom, support and encouragement continues to influence family bonds for success; to my children, Shaun, Chris and Misti, whose inspiring courage, perseverance, dedication, and success are the catalyst that drives my motivation to help others achieve success as they have; and to my husband of 37 years, Stanley, who is my life. Without his support and encouragement, the accomplishment of this 39 year higher-education journey would not have been possible.

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Teachers can only influence student behavior; they cannot directly control it. By knowing which goal students are seeking, teachers can exert positive influence on behavior choices that students make.

(Linda Albert, 2003)

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ABSTRACT

CARLA JENE MACKEY PROCTOR

EDUCATIONAL DIAGNOSTICIANS' PERCEPTIONS ON THE LINK BETWEEN CHC THEORY AND RECOMMENDATIONS OF INSTRUCTIONAL INTERVENTIONS AND ACCOMMODATIONS

MAY 2010

The purpose of this research study was four-fold: (1) to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory, and (4) to determine educational diagnosticians' perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. The study used mixed methodology organized into two phases. Whereas the first quantitative phase utilized survey research, the second qualitative phase utilized focus group research.

The quantitative phase used an online survey for data collection to determine the validity of significant variables generated in survey research. Participants were educational diagnosticians who were all on the Texas registry of professional educational

diagnosticians. The survey was completed by 42 participants. A Likert scale instrumentation rated acquired skills for linking the relationship of CHC cognitive ability and academic learning on a 1-5 point scale rating from "low to high", and extent of recommending instructional interventions and accommodations on a 1-5 point scale rating from "never" to "always". Responses from the survey were analyzed using descriptive statistics and a cross tabulation X^2 test.

The qualitative phase clarified how educational diagnosticians acquired knowledge of linking the relationship of cognitive ability factors to academic learning and their recommendations of instructional interventions and accommodations in the form of a focus group utilizing Metaplan procedures. Five professional educational diagnosticians participated in the focus group.

Results of the study indicated that most educational diagnosticians reported having knowledge of the relationship between CHC theory of cognitive ability factors and academic learning. They also reported that most of them recommend instructional interventions and accommodations based on this knowledge.

The results also specified that most educational diagnosticians receive quality training programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) Theory. However, they reported the need for better formal preparation in linking cognitive ability factors to academic learning. In addition, participants ranked application and communication as the most important barriers when linking CHC theory to academic learning.

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CHAPTER I

INTRODUCTION

The National Center on Educational Outcomes (2009) reported that standards-based reform includes the participation of students with disabilities in state and district assessments in order to measure educational outcomes of programs, including students with a specific learning disability (SLD). This inclusion raises expectations and concerns for decisions regarding instruction and accommodations for improving student performance for those identified with SLD receiving special education services (Christensen, Thurlow, & Wang, 2009). Understanding the nature of academic learning in relation to the neurological basis of SLD as patterns of strengths and weaknesses implicate the need to develop recommendations focused on the relationship between cognitive ability factors and academic learning needs in order to improve student performance.

Federal provisions indicate the importance of collaboration between parents, general education teachers, and special education teachers in an attempt to improve student performance. According to Section 4 of the reauthorization of the Individuals with Disabilities Education Improvement Act (IDEIA, 2004), parent involvement in the process of determining whether a child has a disability is required for the child to qualify for special education services. Additionally, No Child Left Behind: A Parent's Guide (2003) further supports the importance of parental involvement in student education: "Research overwhelmingly demonstrates the positive effect that parent involvement has on their children's academic achievement" (U.S. Department of Education, 2003, p. 10). Several agencies such as The ARC (2005), National Dissemination Center for Children with Disabilities (NICHCY, 2009), Technical Assistance Alliance for Parent Centers (2008), and IDEA Partnership (2009) offer parental resources for the support of parental involvement in the education of students with disabilities. The need for parental involvement implicates a need for possible recommended instructional interventions and accommodations that educators at school and parents at home may use to improve student performance for students with and without SLD.

In addition to parent involvement, NCLB (2004) supports collaboration between special education teachers and general education teachers focusing on the improvement of student performance. This collaboration extends to an evaluator's role of reporting the results of a psycho-educational evaluation and communicating recommendations justified by specific cognitive ability and achievement skill weaknesses (U.S. Department of Education, 2004b). In accordance with the Texas Administrative Code (2002), the educational diagnostician is to "use appropriate communication skills to report and interpret assessment and evaluation results,...provide assistance to others who collect informal and observational data,...[and] effectively communicate to parents/guardians and professionals the purposes, methods, findings, and implications of assessments" (p. 1). The National Clearinghouse for Professions in Special Education (2000) and American Academy of Special Education Professionals (AASEP, 2006) further support the need of the educational diagnostician or Licensed Specialist in School Psychology

(LSSP) to effectively present assessment findings and recommendations to parents, teachers, and administrators.

The reauthorization of IDEIA (2004) states as one of its purposes "to ensure that educators and parents have the necessary tools to improve educational results for children with disabilities…" (p. 5). The *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) was developed for reasons similar to this purpose of IDEIA 2004. The tool assists in the organization and communication of recommendations by directly linking student performance results of a psycho-educational assessment to recommend instructional interventions that are known to improve student performance for children with disabilities. Specifically, this tool links cognitive ability factors with achievement, provides implications of this linkage to academic learning, and offers possible instructional interventions and accommodations to improve cognitive and achievement weaknesses. Utilization of the *Linking CHC to Intervention Tool* assists in effectively communicating assessment results to a collaborative team consisting of an evaluator, parents, educators, and administrators. Implementation of the *Linking CHC to Intervention Tool* will enrich knowledge of student needs and consequently assist in developing effective interventions and accommodations to improve student performance (Proctor & Stephens, 2010).

Areas of Investigation

Federal and State mandates for the identification of a student with SLD necessitate areas of investigation to include: educational provisions for a student identified with SLD, provisions for teachers and parents of a child identified with SLD, and expectations for student performance of students identified with SLD. Therefore, educational diagnosticians must be equipped to link cognitive ability factors with achievement and academic learning based on CHC theory in order to identify the pattern of strengths and weaknesses that affect progress in performance and/or achievement. The knowledge and skills gained from this line of research will better prepare diagnosticians to recommend possible instructional interventions and accommodations to classroom teachers and parents when writing the individual education plan of students with SLD (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling, 2005; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009), as well as make recommendations for students who do not qualify for SLD.

The Amendments to the Individuals with Disabilities Education Act of 2004 explains the purpose of this entitlement to include ensuring "that educators and parents have the necessary tools to improve educational results for children with disabilities by supporting system improvement activities; coordinated research and personnel preparation;" etc., as well as, to assess and ensure the effectiveness of efforts to educate children with disabilities. In response to this legal mandate, the *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) was developed to provide educational diagnosticians and parents with guidelines to improve student performance for students with and without SLD. This tool provides a quick view of the definition of each general intelligence factor of cognitive ability according to CHC theory, achievement skills related to each cognitive ability factor, the relationship of each general intelligence factor to academic learning, and recommended evidenced-based instructional interventions and accommodations to support academic learning based on CHC theory. Therefore, areas of investigation include: (1) the extent to which educational diagnosticians currently possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) the extent to which educational diagnosticians currently recommend possible evidence-based instructional interventions based on CHC theory, (3) the extent to which educational diagnosticians currently recommend accommodations based on CHC theory, and (4) educational diagnosticians' perceptions regarding their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

Federal and state law requires that criteria for an identification of SLD include the provision of effective evidence-based classroom instruction, lack of progress, and a pattern of strengths and weaknesses in performance, achievement, or both performance and achievement (Commissioner's Rules, 2001; IDEIA, 2004; NCLB, 2004). Functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), and perfusion tensor imaging (PTI) research studies indicate neurological correlates of SLD in the areas of reading (Fletcher, Lyon, Fuchs, & Barnes, 2007; Gorman, 2003; Hillis, 2005; Kleinschmidt & Cohen, 2006; Milne, 2005; Poldrack, 2001; Shaywitz, 2003; Tsapkini & Rapp, 2009; Wolf, 2007), writing (Richards, et al., 2009;), and math (Ansari, 2009; Eimeren, Niogi, McCandliss, & Ansari, 2008; Morton, Bosma, & Ansari, 2009; Stanescu-Cosson, Pinel, et al., 2000). Results implicate the possibility of rewiring existing neural network systems for improved academic performance. The design of an ability-oriented evaluation helps to establish a pattern of strengths and weaknesses based on the relationship between cognitive ability factors and achievement based on CHC theory (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling, 2005; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009).

Knowledge of possible recommended instructional interventions and accommodations based on this relationship between cognitive ability factors and academic learning as presented in CHC theory is an important competency for educational diagnosticians. Diagnosticians must be equipped to link cognitive ability factors with achievement and academic learning based on CHC theory in order to identify the pattern of strengths and weaknesses that affect lack of progress in performance and/or achievement. The knowledge and skills gained from this line of research will better prepare diagnosticians to recommend possible instructional interventions and accommodations to classroom teachers and parents when planning the instruction for students with SLD (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling (2005); McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009), as well as make recommendations for students who do not qualify for SLD.

Significance of the Study

Defining Specific Learning Disabilities (SLD)

Legislative definitions of SLD provide a foundation for understanding procedures of specific provisions for students identified with SLD. Initially, the National Advisory Committee on Handicapped Children (NACHC; 1968) provided the basis for federal and state funding for provisions of instructional services for students that meet criteria of a student with a SLD (Hammill, Leigh, McNutt, & Larsen, 1987). The NACHC definition includes the manifestation of one or more cognitive ability weakness to academic learning.

> Children with special specific learning disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written languages. These may be manifested in disorders of listening, thinking, talking, reading, writing, spelling or arithmetic. They include conditions which have been referred to as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental aphasia, etc. They do not include learning problems which are due primarily to visual, hearing or motor handicaps, to mental retardation, emotional disturbance or to environmental disadvantage. (1968, p. 34)

Current criteria needed for the identification of a SLD must include the provision of effective evidence-based classroom instruction and lack of academic progress in the general education curriculum, and may include a pattern of strengths and weaknesses in performance, achievement, or both performance and achievement (National Center for Learning Disabilities, 2009). Amendments to the Individuals with Disabilities Education Act (2004) require Response-to-Intervention as an integral part of "assessment and intervention within a multi-level prevention system to maximize student achievement and to reduce behavior problems" (National Center on RTI, 2010). §89.1040 eligibility criteria of the Commissioner's Rules (2001) describes a student with SLD as "one who exhibits a pattern of strengths and weaknesses in performance, achievement, or both relative to age, grade-level standards, or intellectual ability, as indicated by significant variance among specific areas of cognitive function". Knowledge of these patterns of strengths and weaknesses implicates the need to develop recommendations focused on the linkage of cognitive and academic needs.

Defining Cognitive Ability

Cognitive ability as the psychometric taxonomy of human cognitive ability factors is based on reasoned review and evaluation of research. The psychometric table of human cognitive developments based on Cattell-Horn-Carroll (CHC) theory of cognitive ability represents a factor analysis of the multi-dimensions of general intelligence, also known as *G* (Dehn, 2006; McGrew, 2005). CHC theory identifies these cognitive ability factors of cognitive processing in broad abilities of crystallized intelligence (*Gc*), long term retrieval (*Glr*), short term memory (*Gsm*), fluid reasoning (*Gf*), auditory processing (*Ga*), processing speed (*Gs*), and visual processing (*Gv*; Dehn, 2006; McGrew).

Mather and Wendling (2005) have provided a brief definition describing an individual's experience of each of these cognitive ability factors. Crystallized Intelligence (*Gc*) is an individual's level of acquired knowledge, including main knowledge obtained through life experiences, school and work. Long-Term Retrieval (*Glr*) is the ability to take and store a variety of information (ideas, names, concepts) in one's mind, then later retrieve it quickly and easily using association. Short-Term Memory (*Gsm*) is the ability to apprehend and hold information in an individual's mind and then use it within a few seconds; *Gsm* includes working memory (ability to attend to, process, and respond to information). Fluid Reasoning (*Gf*) is the type of thinking an individual may use when faced with a relatively new task that cannot be performed automatically; a problem solving type of intelligence. Auditory Processing (*Ga*) is the ability to perceive, analyze, and synthesize patterns among auditory stimuli (sounds) and to discriminate subtle nuances in patterns of sound and speech when presented under distortion conditions. Processing Speed (*Gs*) is the ability to fluently and automatically perform cognitive tasks, especially when under pressure to maintain focused attention and concentration. Visual Processing (*Gv*) is the ability to think about and generate, perceive, analyze, synthesize, store, retrieve, manipulate, transform, and think with visual patterns and stimuli.

Defining Academic Learning

Academic learning is the extent to which a student engages and retains knowledge and skills from the curriculum. Nolet and McLaughlin (2000) explained that learned curriculum is curriculum that the student has retained by actively participating in the educational environment of the classroom.

Defining Instructional Interventions

Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3). Evidence-based instructional interventions that improve academic learning assist students in meeting learning standards by promoting academic productivity and achievement (Rathvon, 2008). Instructional interventions provide multiple means of representation, expression, and engagement (Nolet & McLaughlin, 2000).

Defining Accommodations

Instructional accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71). Classification of accommodations include presentation accommodations, response accommodations, scheduling/timing accommodations, setting accommodations, and behavior accommodations related to cognitive ability factor needs (Gregg & Lindstrom, 2008).

Statement of the Purpose

The purpose of this research study was four-fold: (1) to determine to what extent educational diagnosticians possess knowledge on Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory, and (4) to determine educational diagnosticians' perceptions regarding their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

This study design used a quasi-experimental mixed model methodology, which was organized into two phases. The first phase of this study was a descriptive quantitative design utilizing survey methodology. The second phase of the study was a qualitative design utilizing focus group interview methodology.

Research Questions

This study sought to answer the following four research questions:

1. To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to cognitive ability factors?
2. To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to cognitive ability factors?
3. To what extent do educational diagnosticians recommend accommodations related to the relationship of academic learning to cognitive ability factors?
4. What are educational diagnosticians' perceptions regarding the quality of their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory?

CHAPTER II

REVIEW OF LITERATURE

Academic learning occurs as an interactive development of a relationship between a pattern of strengths and weaknesses in the student's biological/neurological development and the richness of the educational environment. Learning disabilities occur when deficits in cognitive abilities result as a consequence of biological/neurological deficits of the student. When the student brings the related neurological/cognitive deficits to interact with the educational environment, deficits in achievement occur. Research studies revealed that enriched environmental influences nurture neurological growth, which strengthens weak related specific cognitive ability factors and areas of achievement. Therefore, an evaluation that identifies specific cognitive ability factor weaknesses linked to specific achievement weakness implicates the nature of academic learning for the student. The provision of specific recommended evidence-based instructional interventions and accommodations based on the relationship of cognitive ability factors and academic learning will enrich the educational environment that nurtures neurological growth, cognitive ability, and achievement. This interrelated process will develop academic learning to improve student performance.

The Nature of Cognitive Abilities

Cattell-Horn-Carroll (CHC) Theory of Cognitive Abilities

Current practices in assessment and interpretation utilize the Cattell-Horn-Carroll (CHC) theory of cognitive abilities to correlate significant variance between cognitive ability and achievement affecting academic learning. CHC psychometric theory structures components of Cattell, Horn, and Carroll's research in cognitive ability factors and academic abilities. Components of CHC theory are portrayed in Table 1.

Raymond Cattell (1941) developed the Dichotomous Fluid-Crystallized (*Gf-Gc*) Theory, as seen in Table 1. He theorized fluid reasoning (*Gf*) as inductive and deductive reasoning abilities that are biological/neurological based and learned through interacting with the environment. He further proposed that and crystallized intelligence (*Gc*) as the primary intelligence of abilities developed from acquired knowledge, influenced by acculturation (Flanagan, Ortiz, & Alfonso, 2007; Mather & Wendling, 2005).

John Horn (1965) expanded Cattell's theory to include additional cognitive ability factors as noted in Table 1. He added auditory processing (*Ga*) in 1968 and reaction time as cognitive speediness (*Gt*) in 1991 (Flanagan, Ortiz, & Alfonso; Horn & Blankson, 2005; Mather & Wendling). John Carroll (1993) introduced his Three-Stratum Theory, which identifies specific narrow abilities that constructs broad abilities, which in turn constructs general intelligence ability (GIA), as described in Table 1.

Stratum III represents general intelligence ability composite, which is the apex of the Three-Stratum Theory. Stratum I consists of narrow abilities related to Stratum II. An example is provided of the eleven narrow abilities relate to crystallized intelligence (*Gc*) in order of strength in the relationship (Carroll, 2005; Flanagan, Ortiz, & Alfonso; Mather & Wendling). Table 1 also includes the abilities included in Stratum II and Stratum III. These narrow abilities identify academic ability related to cognitive ability factors.

Table 1

Theoretical Basis of Cattell-Horn-Carroll (CHC) Theory of Cognitive Ability

CHC Theory Researcher	General Intelligence Ability Factor
Raymond Cattell (1941) *Dichotomous Fluid-Crystallized (Gf-Gc) Theory*	Fluid Reasoning (*Gf*) as inductive and deductive reasoning abilities Crystallized Intelligence (*Gc*) the primary intelligence of abilities
John Horn (1965) expanded Cattell's theory	Fluid Reasoning (*Gf*) Crystallized Intelligence (*Gc*) Visual Processing (*Gv*) Long-Term Memory (*Glr*) Auditory Processing (*Ga*) Short-Term Memory (*Gsm*) Processing Speed (*Gs*) Reaction Time (*Gt*)
John Carroll (1993) *Three-Stratum Theory* identified specific narrow abilities that construct seven broad abilities, which constructs GIA	Stratum III Stratum II Stratum I
Stratum III	GIA Composite
Stratum II includes broad abilities that are ordered by strength of the relationship with crystallized intelligence	Fluid Intelligence (*Gf*) Crystallized Intelligence (*Gc*) General Memory And Learning (*Gy*) Broad Visual Perception (*Gv*) Broad Auditory Perception (*Ga*) Broad Retrieval Ability (*Gr*) Cognitive Speediness (*Gs*) Processing Speed (*Gt*)

(continued)

Table 1, continued

Theoretical Basis of Cattell-Horn-Carroll (CHC) Theory of Cognitive Ability

CHC Theory Researcher	General Intelligence Ability Factor
Stratum I consists of 70 narrow abilities related to Stratum II in order of strength in the relationship. An example of the narrow abilities related to Crystallized Intelligence (*Gc*) is provided.	Crystallized Intelligence(*Gc*) Language Development (*Ld*) Lexical Knowledge (*Vi*) Listening Ability (*Ls*) General Information (*Ko*) Information About Culture (*K2*) General Science Information (*K1*) Geography Achievement (*A5*) Communication Ability (*Cm*) Oral Production And Fluency (*Op*) Grammatical Sensitivity (*My*) Foreign Language Proficiency/Aptitude (*Ki/La*)

Cattell-Horn and Carroll theories differ in the inclusion of the general intelligence ability factor and classification of quantitative knowledge and reasoning ability. They also portray different perspectives of achievement including English-language reading and writing ability as broad vs. narrow abilities. In addition, they vary in perspectives of memory such as short-term memory span and storage and retrieval abilities vs. associative, meaningful, and free-recall memory abilities. CHC theory integrates Cattell-Horn and Carroll models to represent a taxonomy for understanding specific cognitive and academic abilities (Flanagan, Ortiz, & Alfonzo, 2007; McGrew, 2003).

Table 2

Cattell-Horn-Carroll Theory

Cognitive Ability Factor	Definition	Relationship to Academic Learning
Crystallized Intelligence (*Gc*)	The level of acquired knowledge including main knowledge obtained through life experiences, school and work.	*Gc* is highly predictive of academic success, significantly relates to achievement abilities in the areas of basic reading, reading comprehension, math calculations, math problem solving, written, expression, oral expression, and listening comprehension.
Long-Term Retrieval (*Glr*)	The ability to store a variety of information for later quick retrieval using association.	*Glr* is significantly relates to the naming facility of achievement ability in the areas of basic reading, reading fluency, written expression, and oral expression.
Short-Term Memory (*Gsm*)	The ability to apprehend and hold information to use within seconds and includes working memory.	*Gsm* is significantly relates to achievement ability in the areas of basic reading, reading comprehension, math calculations, written expression, oral expression, and listening comprehension.
Fluid Reasoning (*Gf*)	A problem solving type of intelligence that uses inductive and deductive reasoning to understand new tasks.	*Gf* is significantly relates to higher skills of achievement ability in the areas of reading composition, math calculations, math problem solving, and written expression.
Auditory Processing (*Ga*)	The ability to perceive, analyze, and synthesize patterns within auditory sounds.	*Ga* is significantly relates to phonetic coding of early skill development for print language acquisition of achievement ability in the areas of basic reading, written expression and listening comprehension.

(continued)

Table 2, continued

Cattell-Horn-Carroll Theory

Cognitive Ability Factor	Definition	Relationship to Academic Learning
Processing Speed (*Gs*)	The fluid ability to perform cognitive tasks automatically.	*Gs* is significantly relates to the perceptual speed of achievement abilities in the areas of basic reading, reading comprehension, reading fluency, math calculations, math problem solving, and written expression.
Visual Processing (*Gv*)	The ability to think by generating, perceiving, analyzing, synthesizing, storing, retrieving, manipulating, and transforming concepts with visual patterns and stimuli.	*Gv* is significantly relates to visual memory of achievement ability in the area of reading fluency and advanced math of achievement abilities in the areas of math calculations and math problem solving.

CHC theory represents the multi-dimensions of human intelligence based on factor analysis of general intelligence, also known as *G(s)*. These cognitive ability factors are neurological in nature and shaped by environmental experiences. Mather and Wendling (2005) described each of the seven cognitive ability factors and their relationship to academic learning (see Table 2).

As reported in Table 2, these *G* factors have been linked to achievement and academic difficulties experienced by children with and without SLD. The influence of each cognitive ability factor on academic learning implicates a need for instructional interventions and accommodations to focus on meeting cognitive ability factor weaknesses that link to academic learning weaknesses. Recommendations based on this relationship develop both the cognitive ability factor and achievement weaknesses to improve student performance in students with and without SLD.

The Nature of Academic Learning

Relationship of Cognitive Ability and Academic Learning

Jean Piaget's theory of cognitive development identifies intelligence as the basic mechanism of balance in the relationship between an individual and the environment. The environment provides schemes of action that instruct assimilation and provide accommodations that extend application of the schemes to improve academic learning (Piaget, 1950). Therefore, the nature of academic learning is determined by the relationship between an individual's biological/neurological basis of cognitive ability, achievement skill, and educational environment.

A challenge for scientists and practitioners is to move away from developing simplistic hypothesizes on how the mind and areas of the brain develop in relation to skill development of academic learning and move toward building brain models of academic learning abilities. Fischer, Rose, and Rose (2007) explain, "Recent advances of developing neuroscience provide educators with rich descriptions of developing patterns of brain activity and anatomy as they relate to skill development" (p. 114). Webs of brain development contain individual strands of neural substrates responsible for functional specialization related to skill development. Dynamically connected components of brain activity grow in a variety of hierarchically organized and predator-prey relation patterns.

These growth cycles of brain activity relate to cognitive development cycles (Fischer 2008, 2009; Fischer, Rose, & Rose, 2007) that in turn are related to skill development cycles producing a pattern of strengths and weaknesses in brain activity, cognitive, and achievement ability that effect academic learning and student performance. An ability-oriented assessment that focuses on patterns of strengths and weaknesses based on the relationship between specific cognitive ability factors and achievement provides recommendations that nurture an enriched educational environment. These environmental changes influence neurological growth patterns that strengthen cognitive ability and academic skill for improved academic learning and student performance.

Cognitive Process of Learning

Academic learning takes place at the synapse level, which is a critical function of a network of neurons (Jensen, 1998). Environmental differences affect the nature of neural networks. Enriched learning environments nurture neurological growth, resulting in more complex neural systems for learning than natural environments (Jensen; Schwartz & Begley, 2002; Sylwster, 1995). Memories are formed with the activation of a group of neurons that fire together. The activation of one neuron fires to stimulate a standby response in a neighbor cell. Repetitive stimuli for the memory cause a chemical change in the receptors of the neighbor cell, and a bond forms between the cells. Repetition of synchrony firing from the two cells activates chemical change in receptors of any neighborhood cells to "bond together in a distinctive firing pattern, which forms a memory" (Carter & Rita, 1998, p. 160). Therefore, cognitive functions are associated with cognitive neural systems. Environmental differences affect the nature of neural networks. Enriched learning environments nurture neurological growth resulting in more complex neural systems for achieving higher levels of cognitive ability than natural environments for struggling students with and without SLD (Jensen; Schwartz & Begley; Sylwster).

Environmental influences. Environmental support improves neurological growth for effective learning processing. Optimal levels of high instructional support lend to stronger skill level development within the framework of related neurological cognitive development (Fischer, 2008). Differences and potential growth of specific neurological systems associated with academic learning establish the need for enriched learning environments to improve cognitive ability and academic skills for students with SLD, as well as struggling students without SLD. Recommended instructional interventions and accommodations for classroom teachers and parents provide enriched environments of optimal levels of support for improving performance for students with SLD and struggling students without SLD.

Cognitive developmental cycles. Dynamic cycles of cognitive and brain development provide educators with an understanding of the nature of academic learning. Patterns of strengths and weaknesses develop through a process that analyzes and supports the neurological and cognitive development within a common framework of brain and cognition growth. The nature of learning a task does not develop in a linear ladder of sequential progression. It develops as a web of cyclical growth of multiple skill developmental levels during early infancy through adulthood (Fischer, 2009).

Fischer (2008) uses a metamorphic representation of simple building blocks to represent the development of this web of cyclical growth for conceptualizing complex understanding into abstract thinking, as depicted in Figure 1. A dot represents the first level of each cycle of cognitive development in which a child or an adult gains control of a single action, representation, or abstraction for the sensorimotor (Sm) and representation (Rp1) awareness. In the second level, the individual then discovers the relationship between two or more units of knowledge to form a mapping of the actions, representations, or abstractions (Rp2). The third level forms when the individual develops systems by making connections from the relationships between two or more mappings, which develops an abstract awareness of understanding (Rp4/Ab1). In the fourth level, the individual integrates knowledge of two or more systems that forms a system of systems, a new type of unit in which action systems form single representation systems (Ab2), representational systems form single abstractions (Ab3), and abstract systems form single principles (Ab4/P1).

Weaknesses in academic learning inhibit struggling students' access to higher level thinking necessary for comprehension. Recommended interventions and accommodations based on specific cognitive weaknesses limiting academic growth strengthen cyclical development for improved comprehension for students with and without SLD.

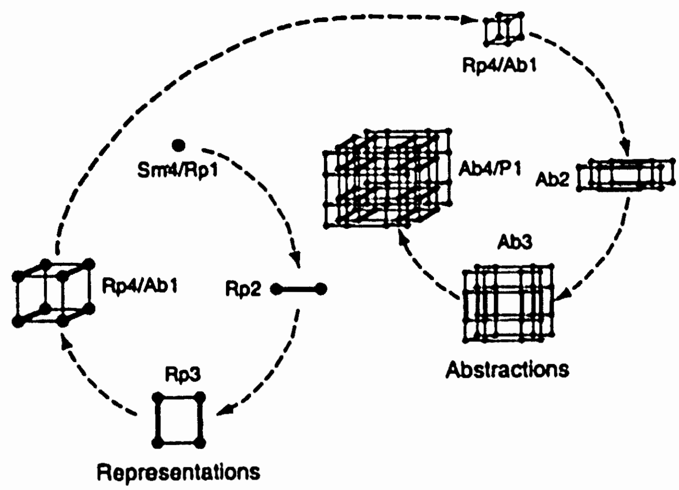


Figure 1. Developmental cycles for tiers of representations and abstractions. Fischer, K. W. (2008). Dynamic cycles of cognitive and brain development: Measuring growth in mind, brain, and education. In A. M. Battro, K. W. Fisher & P. Léna (Eds.), *The educated brain: Essays in neuroeducation,* 127-150, Figure 8.5. Cambridge U.K.: Cambridge University Press.

Instructional support. Levels of instructional support influence the development of abstract thinking necessary for effective academic learning. Cyclical spurts influence effective complex growth patterns of brain activity and cognitive performance. However, optimal conditions of high instructional support strengthen cognitive development for students with and without SLD who struggle with academic learning. Figure 2 denotes age-appropriate development of tiers and levels of skill development with optimal and functional levels of instructional support.

Tiers	Levels	Age of Emergence of Optimal Level	Age of Functional Level
	Ab4 Principles	23-25 yrs	30-45 yrs
Abstractions	Ab3 Systems	18-20	23-40
	Ab2 Mappings	14-16	17-30
	Rp4/Ab1 Single Abstractions	10-12	13-20
Representations	Rp3 Systems	6-7	7-12
	Rp2 Mappings	3½-4½	4-8
	Sm4/Rp1 Single Representations	2	2-5
Actions	Sm3 Systems	11- 13 mos	11- 24 mos
	Sm2 Mappings	7- 8	7-13
	Sm1 Single Actions	3- 4	3-9

Note. Ages for optimal levels are for emergence of the capacity under conditions of support and practice. Ages for functional levels are for ordinary behaviors, which vary widely and are coarse estimates (Fischer & Bidell, 2006). Levels are highly related to education, especially in adulthood (Dawson-Tunik, 2006; Fischer, Yan & Stewart 2003).

Figure 2. Developmental scale of tiers and levels of skills. Fischer, K. W. (2009). Mind, brain, and education: Building a scientific groundwork for learning. *Journal Compilation.* International Mind, Brain, and Education Society and Wiley Periodicals, Inc., 149-161, Table 1, by permission of John Wylie and Sons, provided by Copyright Clearance Center (CCC).

As illustrated in Figure 2, ages of optimal and functional levels of learning differ. As students with and without SLD struggle with the development of complex skills in regards to the development of actions, representations, and abstractions, they fall behind in their ability to conceptualize age and grade level academic learning. In order to close the gap between the ability level and age-appropriate level of performance, struggling students need optimal levels of instructional intervention support to develop cognitive ability factors related to academic learning.

Growth curves and skill development. Growth curves for learning a task develop during three skill levels: (1) novice: chaotic, (2) intermediate: scalloping, and (3) expert:

stable as indicated in Figure 3. Age-appropriate development depends on support level. The novice, chaotic stage of variability requires building and rebuilding a skill, as cyclical, neurological and cognitive discontinuities, and growth influence the specific skill level of development. The intermediate, scalloping stage occurs when the learner is able to maintain a higher level of skill for longer times with periodic episodes of abrupt collapse. After months or years of experience with the skill, the learner moves into the expert, stable stage of consistency as a higher level of skill is sustained for longer periods of time.

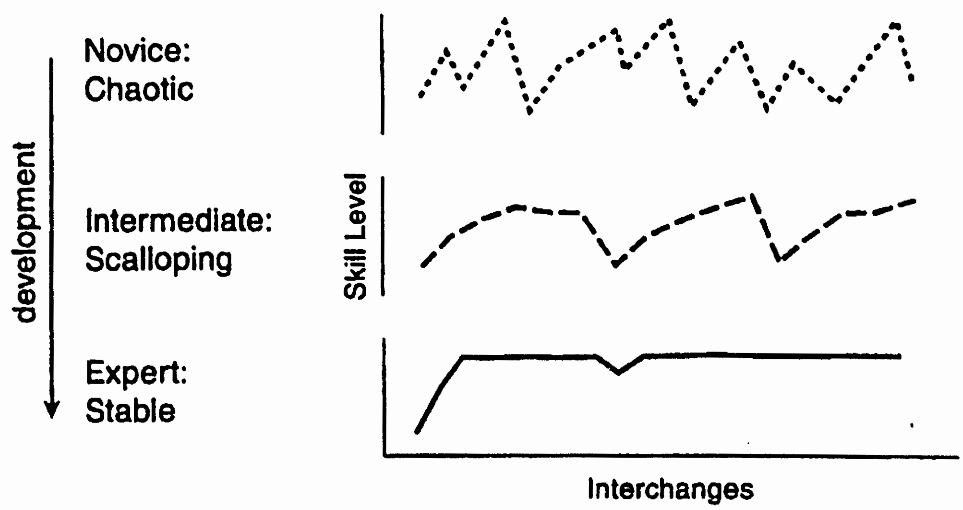


Figure 3. Growth curves for learning a task. Fischer, K. W. (2008). Dynamic cycles of cognitive and brain development: Measuring growth in mind, brain, and education. In A. M. Battro, K. W. Fisher & P. Léna (Eds.), *The educated brain: Essays in neuroeducation*, 127-150, Figure 8.11. Cambridge U.K.: Cambridge University Press.

Figure 3 represents growth curves as three skill levels of learning. The first state, the novice, chaotic skill level is represented by a dotted line pattern of dips and peaks. The second stage, the intermediate scalloping skill level is represented by a scalloping pattern of dashes. The third stage, the expert, stable skill level is represented by the lower curved line. Skill levels develop as complexity in cognitive development matures. As the learner moves through skill levels of difficulty, functional levels of low instructional support influence weak skill level development for struggling students with and without SLD (Fischer, 2008).

In Figure 4, Fischer (2008) represents skill levels of cyclical growth as representations (Rp) and abstractions (Ab) seen in Figures 1 and 2. The cyclical, neurological and cognitive growth in skill level development as peaks in the wavy line indicating optimal learning with high instructional support compared to the dotted line indicating functional learning with low instructional support (Fischer, 2008). Students who receive the functional level of low instructional support develop significantly lower levels of neurological and cognitive development compared to students who receive an optimal level of high instructional support. During each spurt, high instructional support encourages neurological and cognitive discontinuities to occur, as seen in Figure 4. Discontinuities in development are noted in as dips in the wavy line of optimal learning with high instructional support. As neurological and cognitive growth develops through growth spurts and discontinuities, more complex skill levels develop single abstractions, abstract mappings, abstract systems and/or principles. Therefore, struggling students with and without SLD develop neurological and cognitive systems that improve academic learning.

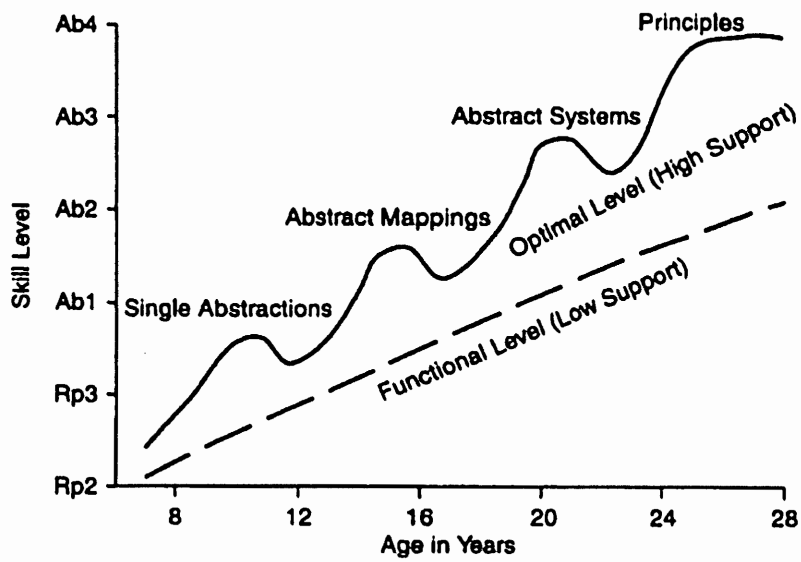


Figure 4. Cyclical spurts for cognitive development under optimal conditions. Fischer, K. W. (2008). Dynamic cycles of cognitive and brain development: Measuring growth in mind, brain, and education. In A. M. Battro, K. W. Fisher & P. Léna (Eds.), *The educated brain: Essays in neuroeducation* 127-150, Figure 8.2. Cambridge U.K.: Cambridge University Press.

Fisher (2008) represents the developmental web of neurological and cognitive growth cycles of skill construction in a metaphoric representation of individual and clusters of strand development marking cycles of optimal levels of instructional support, as depicted in Figure 5. Additionally, the cyclical growth of the three developmental levels of mathematics, self in relationships, and reflective judgment is shown. The clusters marking cycles of optimal levels represent discontinuities of neurological development as optimal levels of high instructional support nurture changes in neurological and cognitive growth and development.

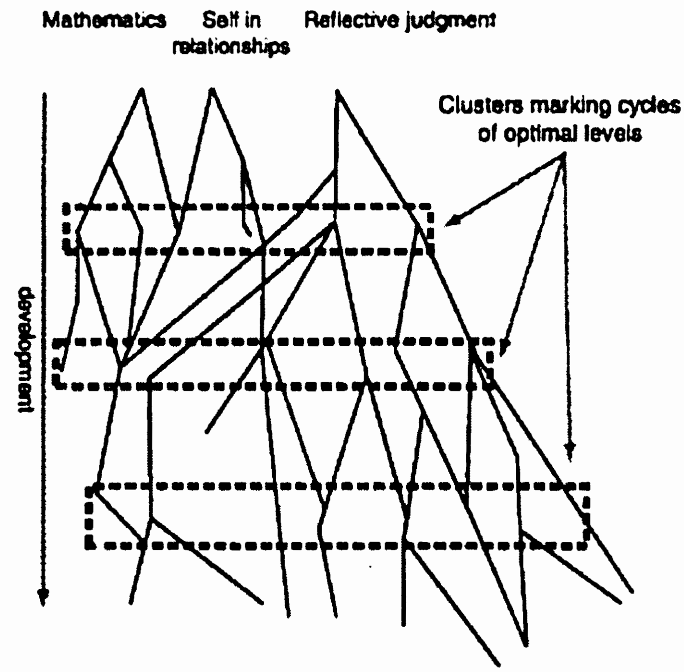


Figure 5. A developmental web of many strands with clusters of discontinuities for three skill levels. Fischer, K. W. (2008). Dynamic cycles of cognitive and brain development: Measuring growth in mind, brain, and education. In A. M. Battro, K. W. Fisher & P. Léna (Eds.), *The educated brain: Essays in neuroeducation* 127-150, Figure 8.3. Cambridge U.K.: Cambridge University Press.

Although a student develops a common complexity scale within several domains of skill development within the multistrand web, skills develop independently. Complexity in skill development occurs as some strands differentiate into new independent strands while other strands merge to form a new integral strand. These strands within domains merge interactively as connections are made between domains such as between conceptions of self as a student and reflections of an understanding of truth. Therefore, the measure of complexity involves separate skills. Struggling students need optimal levels of high instructional support in order to develop abstractions and discontinuities necessary for effective complexity in skill development (Fisher, 2008). As the students develop higher levels of multiple skills, the growth in complexity of neurological and cognitive development improves comprehension ability in academic learning.

Recommendations based on the relationship between cognitive ability factors and academic learning build an enriched educational environment to improve student performance. An ability-oriented assessment that provides educators and parents with an analysis of strengths and weaknesses implicates specific instructional intervention and accommodation recommendations that nurture an enriched educational environment for struggling students with and without SLD. As the cognitive process for building simple representations into abstract understandings and principals interacts with recommended instructional interventions with accommodations, the optimal level of support improves the academic skill levels of struggling students with and without SLD. Therefore, the relationship of cognitive ability and achievement skill strengthened by the influence of optimal support of an enriched educational environment determines the nature of improvement in academic learning.

The Neurological Basis of Academic Learning

Research studies using functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), and perfusion tensor imaging (PTI) have identified neurological deficits in the areas of the brain that process academic learning for struggling students with and without SLD (Morton, Bosma, & Ansari, 2009; Richards et al., 2009; Shaywitz, 2003; Stanescu-Cosson et al., 2000; van Eimeren, Miogi, McCandliss, Holloway, & Ansari, 2008; Wolf, 2007). A specialized magnetic resonance imaging (MRI), fMRI measures the change in blood flow, noted as energy, related to neural activity. MRI is a medical imaging technique used to visualize detailed internal structure and limited functions of the body (Squire & Novelline, 1997). DTI is a MRI that measures the restricted diffusion of water in tissue for neural white matter tracking (Mandl, Schnack, Zwiers, Schaaf, Kahn, & Hulshoff, 2008) by the means of spatial tagging, whereas PTI is a MRI that measures the velocity of perfusion, the delivery of blood indicating level of activation, with a specified angular resolution for reconstruction of the local perfusion field by the means of velocity dependent tags (Frank, Lu, & Wong, 2008).

These non-invasive techniques provide the ability to image microstructures that support structural integrity and directional orientation of white matter tracks (Poldrack, 2001). White matter refers to the regions where collections of axons coated with myelin form tracks (Filley, 2005). These tracks connect grey matter areas. Figure 6 demonstrates the connection for transferring information associated with cognitive ability processes and comprehensive higher-order-thinking. MRI research-based studies using relate neurological processing development to academic ability, which implicate the need for recommended instructional interventions and accommodations for struggling students with and without SLD.

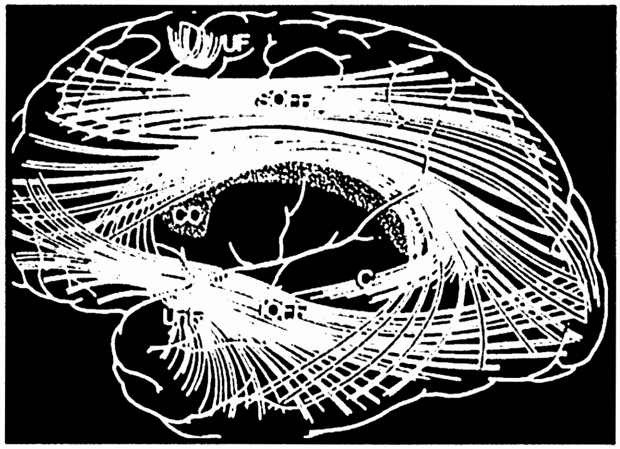


Figure 6. Drawing of major white matter tracks in the human brain. Filley, C. M., 2005, White Matter and Behavioral Neurology, *Annals of the New York Academy of Sciences*, 162-183, Figure 2, by permission of John Wylie and Sons, provided by Copyright Clearance Center (CCC).

The Neurological Basis of Reading

Genetic influence. Genetic and cognitive development influences the nature of neurological development for reading. The genetic link to an ability function involves hundreds and thousands of genes expressed in specific combinations and development sequences (Galaburda & Sherman, 2007). Studies show that while normal genes influence normal behavior, single abnormal genes influence abnormal behavior. Hallgren (1952) documented the genetic link to reading disability in the hallmark study representing 50% of offspring from 90 families having one parent with SLD in reading. Results indicated a strong heritability for the genetic link to SLD in reading.

Researchers have identified the location of susceptible loci, genetic influence, associated with SLD in reading on chromosomes 1, 2, 3, 6, 7, and 18 (Grigorenko, 2003).

Specific neurotransmitters such as gamma-aminobutyric acid within the loci inhibit migration of neurological systems and dendritic growth (Goei et al., 1998). Smith, Kimberling, Pennington, and Lubs (1983) conducted a study with nine families with SLD in reading. These families had abnormalities in the long arm region of chromosome 15. An extension of the study with kindred sibling pairs with clearer analyses strengthened the findings and identified a link to the short arm of chromosome 6 (Smith, Kimberling, & Pennington, 1991).

Grigorenko et al. (1997) found achievement skill weaknesses in phonological awareness linked to chromosome 6 and word decoding linked to chromosome 15 in a student with six extended families. Gaylan et al. (1999) found a link between orthographic and phonological processing and the 5cM area on chromosome 6 in a study of 126 sibling pairs with SLD in reading. In addition, Fisher et al. (1999) found a link between reading irregular words and nonwords and 6p21.3 area on chromosome 6 in a study of 181 sibling pairs with SLD in reading from 82 families. The abnormal genetic function of these abnormal chromosome developments are associated with ectopias, small malformations of the cerebral cortex of the brain, resulting from altered neural migration during fetal development (Galaburda & Sherman, 2007).

Specific genes related to the neurological basis of reading include ROBO1 gene on chromosome 3 (Hannula-Jouppi et al., 2005), DCDC2 and KIAAO319 on chromosome 6 (Frenkel, Sherman, Bashan, Galaburda, & LoTurco, 2000), and DYX1C1 on chromosome 15 (Taipale et al., 2003). The link between abnormal chromosome development and basic reading skill development implicates a genetic basis for cognitive ability deficits in struggling students with and without SLD in reading. Cognitive ability deficits are a consequence of abnormal neurological system development that results in changes of visual and auditory systems. Changes in neurological processing areas for low and high levels of information result in sensory and perceptual deficits related to the neurological basis for reading (Galaburda & Sherman, 2007).

Galavurda and Sherman (2007) explained genetic research development:

> The next giant steps involve specifying the exact gene loci, and then cloning and sequencing the gene(s). Determining their function and defining their relationship to the phenotype [visible characteristics] would be next. (p. 40)

The genetically linked neurological development affects cognitive development related to all areas of achievement. The strengths and weaknesses related to the relationship between cognitive ability factors and academic learning are a consequence of neurological development. An ability-oriented evaluation is needed to identify patterns of strengths and weaknesses that determine student needs. Recommendations of instructional interventions and accommodations based on the weaknesses of the relationship between cognitive ability and academic learning create enriched environmental influences that nurture the rewiring of neurological systems from ectopias to improve student performance in reading.

SLD in reading. Current definitions representing SLD in reading refer to the specific reading disability as dyslexia. The Texas Education Agency (TEA, 2007) represents the current definition of dyslexia adopted by the International Dyslexia Association (2002):

> Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge. (Adopted by the International Dyslexia Association Board of Directors, November 12, 2002, p. 1)

TEA (2007) further explains *other cognitive abilities*:

> Examples of other cognitive abilities that could be age appropriate in relation to unexpected reading difficulties might include the student's oral language skills, his/her ability to learn in the absence of print, or strong math skills in comparison to reading skills. (p. 37)

The prevalence of dyslexia is estimated to be from 5% to 17% of students in the United States. Dyslexia, affecting 80% of all individuals identified with SLD, is the most widely researched SLD (Hay, Elias, Fielding-Barnsley, Homel, & Freiberg, 2007; Shaywitz & Shaywitz, 2003). In accordance with the current definition of dyslexia and research representing dyslexia as a SLD in reading for the purpose of this dissertation, dyslexia is referred to as *SLD in reading*.

Neurological systems for basic reading. In the reading process, activation of neural systems generally occurs in the left hemisphere of the brain for good readers and more diffused across the two hemispheres in readers with SLD in reading in word decoding and word identification. While right hemispheric systems can support accurate, slow reading, essential left hemispheric systems support fast, fluent automatic reading (Fletcher, Lyon, Fuchs, & Barnes, 2007; Shaywitz, 2003). Functional magnetic resonance imaging (f-MRI) of gray matter processing reveals that in good readers, activation occurs in three main areas of the left hemisphere: the inferior frontal gyrus, the parietal-temporal, and the occipital-temporal area.

The phoneme producer is located in the inferior frontal gyrus where phonological processing and speech typically occur. This area assists with the beginning of phoneme recognition as sounds are pulled apart through silent or oral vocalization of the spoken word (Gorman, 2003).

The word analyzer, located in the parietal-temporal area, assists with word decoding by mapping of the letter shapes to individual phoneme sounds, which occurs in the word analyzer, an upper circuit pathway that leads to the phoneme producer. Knowledge of the letter-to-sound association, the alphabetic principle, facilitates the reading process by decoding unknown words.

Automaticity, located in the occipital-temporal area, promotes rapid automatic recognition of letters and words (Gorman, 2003; Milne, 2005; Shaywitz, 2003). When mapping of the letter shape to phoneme sound occurs in the phonological processor of the phoneme producer, letters and their corresponding sounds are learned.

When a new word is read for the first time, there is no previous entry in the automatic word form recognition subcomponent area of the occipital-temporal area, so automaticity does not occur. When mapping of the letter shapes to individual phoneme sounds occurs in the word analyzer, an upper circuit pathway leads to the phoneme producer and sound blending utilizes phonemic awareness skills to produce the word. A snapshot of the word is entered in the automatic word form recognition area of the occipital-temporal area, which is linked to the speech production subcomponent of the phoneme producer in the brain's inferior frontal gyrus.

When a word is recognized as a known word, it is automatically accessed from the automatic word form recognition subcomponent area. A lower circuit pathway links the automatic recognition quickly to speech production, which enables the word to be pronounced (Milne, 2005; Shaywitz, 2003). Good readers utilize this process to facilitate fluent reading, which links decoding to comprehension. Hall and Moats (1999) explain the effect of a proficient link. Good readers "recognize letters in groups or chunks, break words into syllables with little conscious analysis, use their knowledge of how words are spelled to read by analogy, employ their knowledge about the way a written text is structured, and activate their extensive vocabulary" (p. 137). Good readers utilize all three areas of the brain to access the printed word to develop comprehensive knowledge.

Figure 7 represents a study of differences in neurological development of basic reading abilities through a comparison of activity between students with SLD in reading noted as dyslexia (DYS) in the top row of slides and nonimpaired (NI) readers. Students with SLD in reading do not process reading in all three areas of the brain like good readers (Shaywitz et al., 2008). The top slides of Figure 7 demonstrate that students with SLD in reading typically overactivate the frontal area and underactivate the parietal-temporal and occipital-temporal areas. They develop disorganized systems that utilize right hemispheric systems to support accuracy in reading. However, the processing is slow and labored (Shaywitz, 2003).

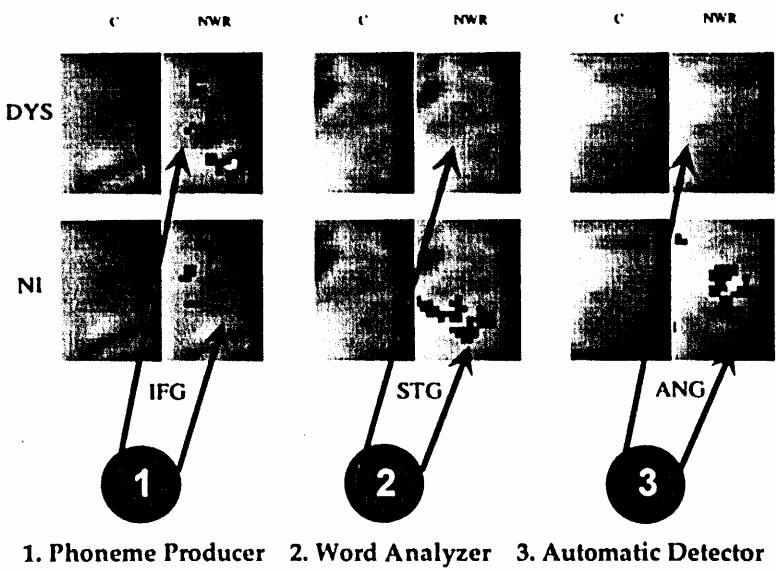


Figure 7. Language processing: What goes wrong? Shaywitz, S. E. et al. (1998). *Figure 2.* Functional disruption in the organization of the brain for reading in dyslexia. *Proc. Natl. Acad. Sci. USA 95(5),* 2636-2641

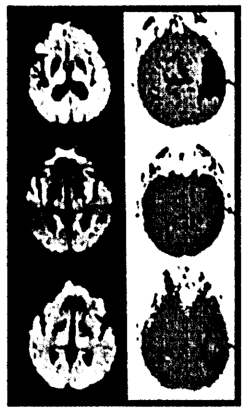
In contrast, the bottom slides of Figure 7 demonstrate activation in all three areas of the brain. Combined f-MRI scans of gray matter, typically consisting of nerve cells and diffusion tensor imaging (DTI) scans, typically consisting of nerve fibers connecting areas of gray matter, reveal neural disorganization resulting from ectopias, misplaced and poorly connected neurological systems, in individuals identified with reading disabilities (Hillis, 2005). Results of these neurological deficits are linked to deficits in cognitive abilities necessary for effective reading ability.

Poor neurological processing systems causing poor cognitive development for basic reading implicate the need of effective instructional interventions and accommodations for academic learning. Cognitive processes related to basic reading skills include crystallized intelligence (*Gc*), subtests of language development (*Gc-LD*), subtests of lexical knowledge (*Gc-VL*), subtests of listening ability (*Gc-LS*); processing speed (*Gs*; Flanagan, Ortiz, & Alfonso, 2007); phonological awareness, phonetic coding, of auditory processing (*Ga*); short-term memory (*Gsm*); rapid automatic naming facility of long-term retrieval (*Glr*; Dehn, 2006; Flanagan, Ortiz, & Alfonso, 2007; U.S. Department of Education, 2004a); working memory; and successive processing, which is the linear, sequential process of decoding of words in working memory (Dehn, 2006).

Neurological systems for reading fluency. A relationship between white matter structure and reading ability in good readers and individuals with SLD in reading has been determined through DTI, a type of magnetic resonance imaging used to study the microstructure integrity of white matter (Poldrack, 2001). Increased activation in specific white matter tracks representing visual word form recognition evidence slower processing (Hillis, 2005). Dr. Walsh, chief of the Division of Genetics at Children's Hospital Boston and Professor of Neurology at Harvard Medical School, explains: "… poor reading fluency – slow and choppy reading – may be caused by disorganized, meandering tracts of nerve fibers in the brain" (Newton & Prescott, 2007).

Shaywitz (2003) identified similar differences in word recognition and activation in areas of the brain. A disruption in the left posterior processing systems of the brain inhibited rapid word recognition and developed supplementary right hemispheric systems resulting in slow, labored reading. Evidence from f-MRI scans of the ectopias, disorganized regions, may be seen as deep nodules of gray matter within the brain compared to surface formation of gray matter in good readers. DTI scans give evidence of a laborious integration of information by white matter fibers meandering circuitous routes around misplaced gray matter rather than bundled organized sequential fiber tracks from surface gray matter areas in good readers. This disorganized structure inhibits integration of information for rapid, automatic reading. Variation in severity of the disorganized white matter fibers correlates with severity in fluency evidenced by poor reading fluency scores (Newton & Prescott, 2007).

Hillis (2005) represents this disruption through a study of stroke patients that demonstrated a very high correlation between delayed activation and error rate in a word comprehension test similar to students with SLD in reading, as shown in Figure 8. Severity of disruption in white matter tracks processing resulted in significant variance of word naming ability. Effective white matter tracks transfer information interhemisphericly access left areas of the brain for print language processing and right areas to access word naming and word comprehension. The severity of disrupted white matter tracks access to left hemispheric areas of the brain responsible for processing the printed word inhibits access to word naming and word comprehension areas of the brain. Connections between decoding printed words, automatically and fluently recognizing words, and automatically accessing word meaning through these interhemispheric connections comprising a network of regions support particular cognitive tasks of reading comprehension and written expression.

A.  Mild

B. Moderate

C. Severe

Figure 8. Severity of word comprehension. Severity of hypoperfusion in Wernicke's area corresponds to severity of word comprehension deficit (Top) DTI (left) and PTI (right) of a patient with mild relative delay in TTP in Wernicke's area and mild word comprehension impairment. (Middle) DTI (left) and PTI (right) of a patient with moderate relative delay in TTP in Wernicke's area and moderate word comprehension impairment. (Bottom) DTI (left) and PTI (right) of a patient with severe relative delay in TTP in Wernicke's area and severe word comprehension impairment. The (red) arrow points to Wernicke's area.
Hillis, A. E., 2005, Brain/Language Relationships Identified with Diffusion and Perfusion MRI: Clinical Applications in Neurology and Neurosurgery, *Annals of the New York Academy of Sciences*, 149-161, Figure 5, by permission of John Wylie and Sons, provided by Copyright Clearance Center (CCC).

The relationship between cognitive processing deficits and poor reading fluency implicate the need of effective instructional interventions and accommodations for academic learning. Cognitive processes related to reading fluency include: the naming facility of long-term retrieval (*Glr*); processing speed (*Gs*; Flanagan, Ortiz, & Alfonso, 2007; U.S. Department of Education, 2004a); and visual memory of visual processing (*Gv*; Flanagan, Ortiz, & Alfonso).

Neurological systems for reading comprehension. Core reading deficits in basic reading skills and reading fluency affect secondary reading skills necessary for reading comprehension. Fletcher, Lyon, Fuchs, and Barnes (2007) refer to disfluency as the underlying cause of low comprehension ability. "[M]any...students may be unable to comprehend primarily because their slow reading rate places too many demands on their ability to process what they have read" (p. 179). Developing the primary core skill of reading speed with prosody improves automaticity in word recognition and textual reading necessary for students to become fluent readers.

In word identification, a deficit in phonological processing impedes the ability of a child to segment the printed word into underlying phonetic elements. Without a strong foundation in phonological awareness, the phonetic association between grapheme (letter) and phoneme (sound), the alphabetic principal, is not well developed. As a result, a weak relationship between the phonological processing and orthographic processing develops, causing poor phonetic reading of decodable words, poor orthographic reading of identified word patterns and sight word recognition, and poor naming speed (Hook & Jones, 2004; Pikulski & Chard, 2005; Shaywitz & Shaywitz; 2003; Wolf, Gowers, & Biddle, 2000). Therefore, phonological and orthographic processing deficits of language processing block access to higher-order cognitive abilities for effective comprehension, which explains why an intelligent child unexpectedly experiences reading failure (Fletcher, Lyon, Fuchs, & Barnes, 2007; Shaywitz, 2003). These deficits affecting intra-relational processing of the multidimensional reading process impede the vocabulary development and reading experience necessary for reading comprehension.

The functional specialization of neural substrates reflects whether a given area of the brain is the exclusive cortical place for that particular function (Kleinschmidt & Cohen, 2006). Tsapkini and Rapp (2009) explored the specialized function of the left-mid-fusiform gyrus to determine if dedicated neural substrates that specialize in orthographic processing of the written word caused word retrieval ability. The subject, a tax attorney, had a single 3 to 4 minute episode of aphasia, which caused difficulties in short-term memory and related skill areas of spoken naming, reading comprehension, and spelling.

The control group consisted of eleven subjects, 6 men and 5 women ages 31 through 41, who had completed higher education degrees: 2 with BA degrees, 8 with MA degrees, and 1 with a PhD degree. Results of computer-based tasks indicate strong evidence that neural substrates within the left-mid-fusiform are dedicated to orthographic processing and representation. Therefore, the functional specialization of the neural substrates reflects that the left-mid-fusiform gyrus are dedicated to orthographic processing and representation necessary for effective reading comprehension and written expression.

Other DTI research further explains the connected effects of slow and labored reading to reading comprehension and implications for intervention. Research studies of individuals with aphasia experience difficulties in reading similar to individuals with SLD in reading. White matter activation appears to represent a delay in syntactic (word order) and semantic (word meaning) processing in individuals with language comprehension impairment (Hillis, 2005; Poldrack, 2001). Hillis explored the role of the mid-fusiform gyrus of the left hemisphere of the brain in language comprehension through a study of stroke patients depicted in Figure 9.

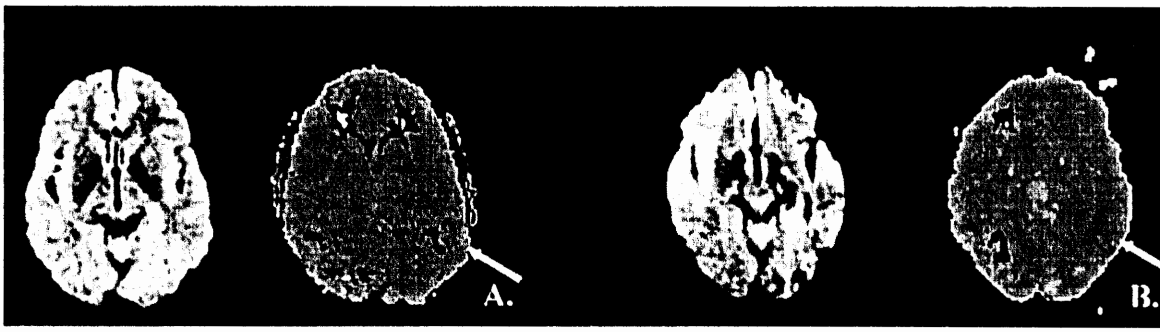


Figure 9. Neurological basis of poor vs. good word comprehenders. Reperfusion of left midfusiform gyrus and surrounding cortex resulted in recovery of naming and reading (Two Left Pannels) DWI (left) and PWI (right) before intervention to improve blood flow. (Two Right Panels) DWI and PWI after intervention. In these and all PWI figures, TTP maps are shown: dark areas are areas of delayed TTP ("hyperfusion"), light areas are areas of relatively normal TTP. The arrow points to left midfusiform gyrus.
Hillis, A. E., 2005, Brain/Language Relationships Identified with Diffusion and Perfusion MRI: Clinical Applications in Neurology and Neurosurgery, *Annals of the New York Academy of Sciences*, 149-161, Figure 1, by permission of John Wylie and Sons, provided by Copyright Clearance Center (CCC).

Decreased activation in white matter tracks of this area were directly associated with oral and written word comprehension, as seen in image A of Figure 9. Ineffective, abnormal function showed more activation of right hemispheric areas of the brain with printed word comprehension, oral picture naming, oral tactile naming, and printed word naming (Hillis, 2005). The increased activation in the right hemispheric area of the brain indicated delayed retrieval of words, seen as dark blue areas of image B. This activation represents longer time spent in an allocation of energy to identifying and comprehending printed words. After effective intervention, increased activation in the left mid-fusiform gyrus of the left hemispheric area of the brain and decreased activation in right hemispheric areas of the brain occurred as word comprehension improved.

Poldrack (2001) identified similar results in functional connectivity related to reading comprehension deficits in students with SLD in reading. Disrupted functional connectivity of the angular gyrus, causing a reduction, also reduced axon size in long myelin white matter tracks connecting frontal, parietal, and occipital areas of the brain for students with SLD. This disruption may result from impairments of audio and visual modalities of dynamic sensory processing associated with rapid transmission of neural signals. This delay of language comprehension and naming speed, which causes more energy in the basic skill of knowledge development, inhibits allocation of effective energy to higher order thinking necessary for developing effective oral and print language comprehension.

Rewiring neurological systems for reading. Additional f-MRI and DTI research reveals that rewiring of neural systems is possible as seen in Figure 10. Shaywitz (2003) explains the findings. "After more than a century of frustration, it has now been shown that the brain can be rewired and that struggling children can become skilled readers" (p. 86). Studies demonstrate the success of this rewiring process with the development of all three areas of the left hemisphere. This evidence is demonstrated by continued activation one year following effective reading intervention.

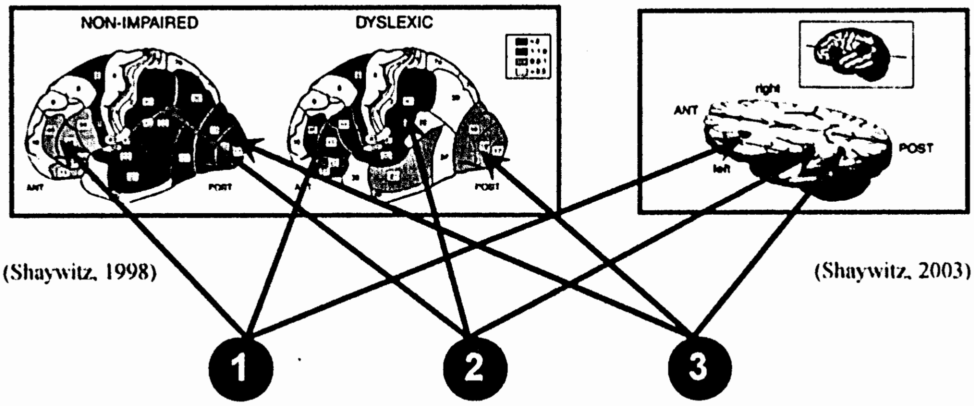


Figure 10. New neurological pathways: Making the connections. Shaywitz, S. E. et al. (1998). *Figure 3.* Functional disruption in the organization of the brain for reading in dyslexia. *Proc. Natl. Acad. Sci. USA 95(5)*, 2636-2641; Shaywitz, S. E. (2003). *Figure 28.* Effective reading interventions result in brain repair. *Overcoming Dyslexia.* New York, NY: Alfred A. Knopf, 86.

The enriched environmental provision of effective evidenced-based interventions was powerful evidence that the neurological and cognitive development of decoding, reading fluency, and reading comprehension skills allowed the students to close the gap of achievement by reading at the same levels of their peers (Fletcher, Lyon, Fuchs, & Barnes, 2007; Shaywitz, 2003). Therefore, the provision of evidenced-based instructional interventions provides students with SLD in reading with an enriched environment that nurtures neurological and cognitive processes and improvement of student progress in academic learning.

The neurological development of basic reading, reading fluency, and reading comprehension skills affect student performance in subject areas across the curriculum requiring print language such as mathematics, science, and social studies. The provision of recommended instructional interventions and accommodations based on the relationship between cognitive ability factor weaknesses and achievement weaknesses improve neurological systems for reading to improve student performance across the curriculum.

The relationship between cognitive processing deficits and poor reading comprehension development implicate a need for effective instructional interventions and accommodations for academic learning. Cognitive processes related to reading comprehension include: crystallized intelligence (*Gc*), subtests of language development (*Gc-LD*), subtests of lexical knowledge (*Gc-VL*), subtests of listening ability (*Gc-LS*; Flanagan, Ortiz, & Alfonso, 2007), processing speed (*Gs*), short-term memory (*Gsm*); fluid reasoning (*Gf*; Dehn, 2006; Flanagan, Ortiz, & Alfonso; U.S. Department of Education, 2004a), working memory; and planning and organization of executive processing (Dehn, 2006).

Neurological basis of written expression. Written language skills are highly associated with reading language skills. Automaticity in handwriting transcription is relevant for translating higher-order cognitive processes to spell words at the written word, sentence, and text levels. Research in fMRI reveals that in new letter and practiced letter formation, children with good writing skills and children with poor writing skills showed similar activation in specific brain regions. However, when poor writers wrote a new pseudo letter, they experienced significantly more activation in common and different brain regions than good writers who wrote the same new pseudo letter. The role of the orthographic loop in transcription from internal letter form to external letter handwriting may be a part of working memory and appears to be important for translating higher-order cognitive processes of thinking to spell words and create expressive written text (Richards et al., 2009).

Written language processing is also essential for print language success to validate and expand knowledge gained during the reading process in subject areas across the curriculum. Richards et al. (2009) conducted a study that provided evidence of neurological differences in writing skills for good and poor writers, as noted in Figures 11 and 12. Figure 11 shows that good writers utilize specific right, left, and midline areas of the brain for handwriting. Poor writers, however, activate different left and right hemispheric areas of the brain for handwriting (see Figure 12). They have less activation in the specific areas of the brain than good writers and more activation in both left and right hemispheric areas of the brain, indicating disorganization of neurological systems compared to good writers.

Twelve good writers portrayed in Figure 11, and 8 poor writers shown in Figure 12, who are 11 years of age, engaged in writing activities using a newly learned pseudoletter and a highly practiced letter. The first fMRI contrast compared neurological systems between the writing of a newly learned pseudoletter and a highly practiced letter. Results revealed that although many common areas of the brain were activated by both good and poor writers, poor writers spatially activated more extensive brain activation than good writers, as seen in the group maps of fMRI activation for handwriting contrast showing left and right surface-rendered views of the brain in Figures 11 and 12. These additional regions of increased activation implicate ineffective cognitive processing for learning a new letter in students with poor writing ability.

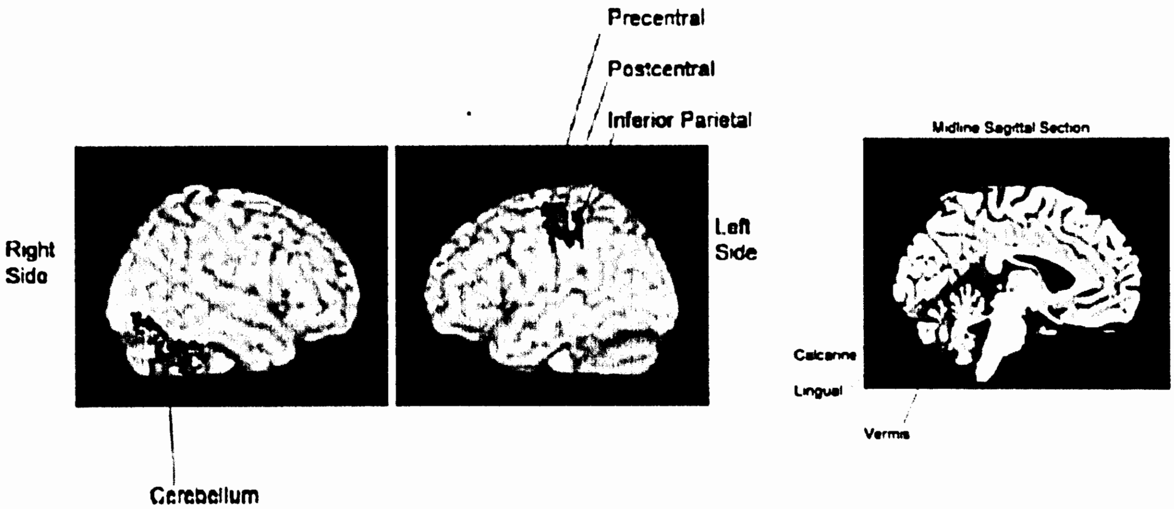


Figure 11. Good writers utilize left and right areas of the brain. Group map for fMRI activation for handwriting contrast (novel vs. familiar) for good writers (n = 12) showing left and right surface-rendered views of the brain and group map showing midline sagittal section of the brain so that midline structures can be seen (vermis, calcarine, lingual). With kind permission from Springer Science+Business Media: *Reading and Writing*, Differences between good and poor child writers on fMRI contrasts for writing newly taught and highly practiced letter forms, 2009, 1-24, Richards, T. L., Berninger, V. W., Stock, P., Altemeier, L., Trivedi, P., & Maravilla, K. R., figures 1 and 2.

The second fMRI contrast focused on specific clusters of activation during the writing of a newly learned pseudoletter and a highly practiced letter for good and poor writers. Group maps of fMRI activation for handwriting task contrast revealed that three regions of the brain are utilized for good writers (see Figure 11). These regions, located in the midline sagittal section of the brain, compared to five regions, located in the coronal and midline sections of the brain, that are utilized for poor writers (see Figure 12). These findings revealed significant correlations in the brain-behavior relationship between the left fusiform and both automatic writing and expressive orthographic coding. Differences in both brain and behavior explain significant variance in written composition between good and poor writers.

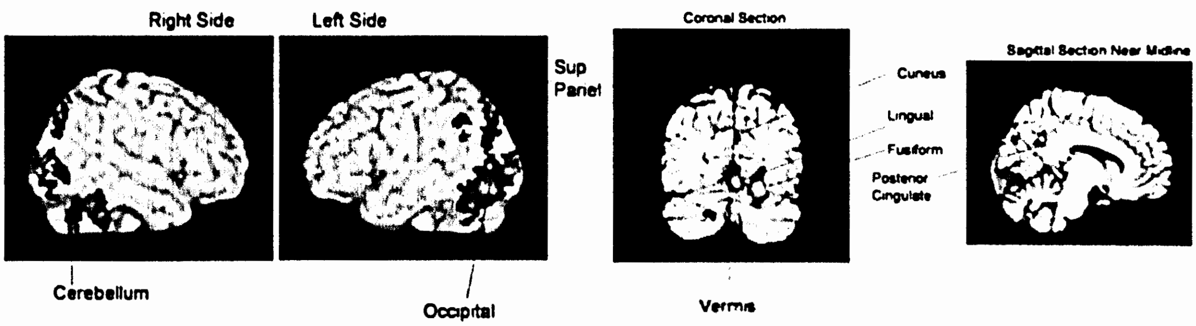


Figure 12. Poor writers utilize more activation with many common left and right areas of the brain as good writers. Group map of fMRI activation for handwriting contrast (novel vs. familiar) for poor writers showing left and right surface-rendered views of the brain and group map of fMRI activation for handwriting task contrast (novel vs. familiar) for poor writers showing coronal and midline sections so that midline structures can be seen (fusiform, lingual, cuneus, posterior cingulate, vermis). With kind permission from Springer Science+Business Media: *Reading and Writing*, Differences between good and poor child writers on fMRI contrasts for writing newly taught and highly practiced letter forms, 2009, 1-24, Richards, T. L., Berninger, V. W., Stock, P., Altemeier, L., Trivedi, P., & Maravilla, K. R., figures 3 and 4.

The relationship between cognitive ability factor weaknesses related to writing achievement weaknesses implicate possible recommended instructional interventions and accommodations. These recommendations provide environmental support to nurture neurological growth for improved handwriting transcription. Since automaticity in handwriting transcription reduces neural activity, more activation may be allocated to higher-order cognitive processing for developing expressive thought to improve student performance in written composition.

The relationship between cognitive processing deficits and poor written expression implicate a need for effective instructional interventions and accommodations for academic learning. Important cognitive processes responsible for the development of basic writing skills of written language include phonemic processing critical for symbol-to-sound association, which is measured by auditory processing (*Ga*), working memory for holding information to construct into sentences, processing speed (*Gs*), and long-term storage and retrieval (*Glr*; Dehn, 2006; U.S. Department of Education, 2004a).

For struggling students with and without SLD in written expression who experience difficulty with handwriting, the cognitive process of letter formation for spelling and written text may inhibit allocation of attention to higher-order-thinking necessary for effective written expression. Cognitive processes related to written expression include: crystallized intelligence (*Gc*), subtests of language development (*Gc-LD*), subtests of lexical knowledge (*Gc-VL*), and subtests of general information (*Gc-KO*; Dehn, 2006; Flanagan, Ortiz, & Alfonso, 2007; U.S. Department of Education, 2004a), fluid reasoning (*Gf*), auditory processing (*Ga*), short-term memory (*Gsm*), processing speed (*Gs*), and planning and organization of executive processing (Dehn, 2006; U.S. Department of Education, 2004a). Written language processing is also essential for print language success to validate and expand knowledge gained during the reading process in subject areas across the curriculum.

Neurological Basis of Math

While many students experience a co-morbidity or co-existence of deficits in reading and written language due to high associations between the two, in some ways the neurological basis of mathematical abilities allocates a different set of high associations. In other ways, mathematical abilities allocate a set of basic associations similar to reading and writing abilities. Although mathematical disability is considered a separate disorder, fMRI and DTI research reveal that mathematical calculation and reasoning neurological processing utilize some of the same regions of the brain as language processing. Differences in activation for exact calculation and mental math abilities implicate differences in activation for higher-order mathematical ability. A correlation between mathematical ability and the integrity of left hemispheric white matter tracks indicate a neurological basis for individual differences in mathematical ability.

Neurological systems for math calculations. Stanescu-Cosson et al.'s (2000) fMRI research study reveals differences in response activation, measured by response time and error rates for number processing, noted in Figure 13. In exact calculation, larger numbers employ greater activation than smaller numbers; however, in approximation there were no significant differences in activation. Simple addition problems that have been memorized through rote memory show little or no activation. In contrast, exact calculations of large numbers and approximation of small and large numbers indicate a significant increase in activation in subregions of the parietal lobe of the brain.

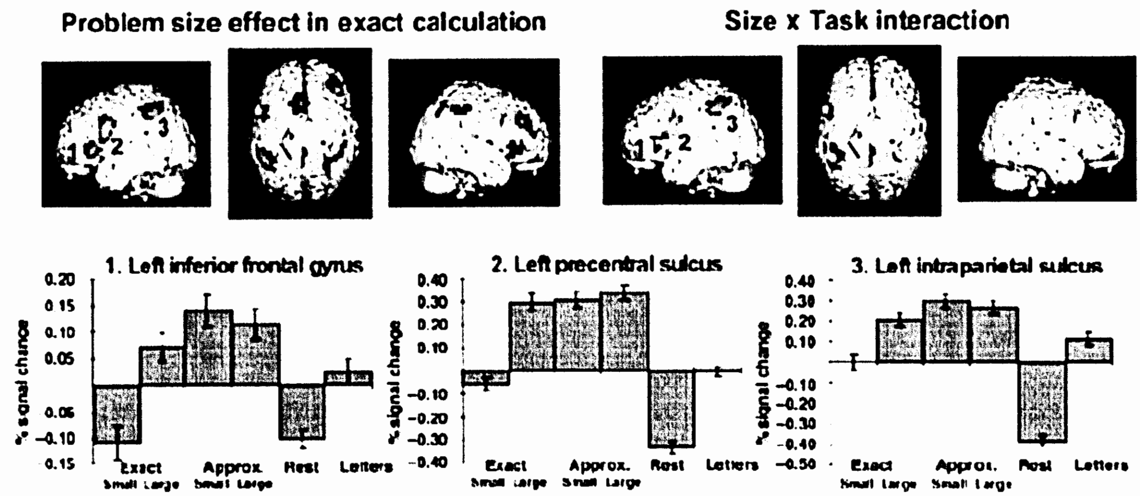


Figure 13. Effect of problem size on brain activation patterns. Top row: areas showing greater activation in response to large than to small numbers during exact calculation. Bottom row: interaction of size and task, showing areas where a greater problem size effect was in exact than in approximate calculation, paralleling behavioral results. Stanescu-Cosson, R., Pinel, P., van de Moortele, P. F.Bihan, D. L., Cohen, L. & Dehaene, S., 2000, Understanding dissociations in dyscalculia: A brain imaging study of the impact of number size on the cerebral networks for exact and approximate calculations. *Brain.* 123, 2240-2255. Figure 5.

Rote arithmetic calculation of small numbers employs the left-lateralized regions of the brain, which may encode numbers in a verbal format represented as *Size x Task interaction.* Exact large number calculations and approximation employ stronger emphasis in the left and right parietal regions of the brain, which may encode numbers in a nonverbal quantity format referred to as *Problem size effect in exact calculation.* Implications suggest that specific weaknesses in mathematics are related to weaknesses in verbal and/or quantity abilities.

Morton, Bosma, and Ansari (2009) further support these findings with fMRI research in mental math age related activation of neurological differences. Students with good math skills in math calculations and math reasoning develop age appropriate mental math such as spatial or distance effect, which is the understanding that when numbers are farther apart, quick judgment confirms one number to be larger than the other. Measures of cued dimensional switching indicate developmental changes in prefrontal cortex. Age-related shifts due to mental math function maturity occur, as illustrated in Figure 14.

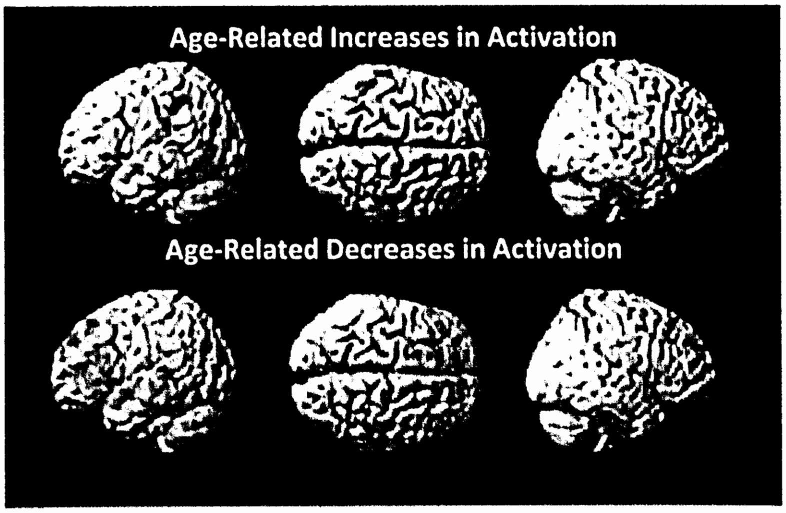


Figure 14. Mental arithmetic. Surface rendering of significant increases (top) and decreases (bottom) in activation for mental arithmetic trails.
Rivera, S. M., Reiss, A. L., Eckert, M. A., & Menon, V., Developmental Changes in Mental Arithmetic: Evidence for Increased Functional Specialization in the Left Inferior Parietal Cortex, *Cerebral Cortex,* 2005, 15, 1779-1790, by permission of Oxford University Press.

These shifts develop as a decrease in activation of the prefrontal area of the brain occurs, in correlation with a decrease in reaction time. These decreases yield to an increase in activation of the parietal area of the midbrain, in correlation with an increase in reaction time. Implications indicate that struggling students with and without SLD in math may engage in much more cumbersome cognitive processing for basic math calculations involving the prefrontal cortex, and less engagement in left and right hemispheric regions related to complex mental math ability. A delay in age-related mental math processing may inhibit higher-order thinking necessary for math reasoning.

Neurological systems for math problem solving. DTI research by Eimeren, Niogi, McCandliss, and Ansari (2008) revealed specific left hemispheric white matter tracks that are significantly related to individual differences of strengths and weaknesses in math abilities for math reasoning achievement skills, as portrayed in Figure 15. Raw scores of standardized measures of mathematical abilities were correlated with fractional anisotropy (FA), used to measure white matter integrity. While higher raw scores represented stronger mathematical ability, higher FA values represented stronger white matter tracks with more constrained diffusion with less variance in directional flow. Implications of their research suggest that while students with good math calculations and/or math reasoning skills develop effective white matter tracks within two main regions of the left hemisphere of the brain, struggling students with and without SLD in math calculations or math reasoning have not developed effective left hemispheric white matter tracks for effective mathematic achievement abilities.

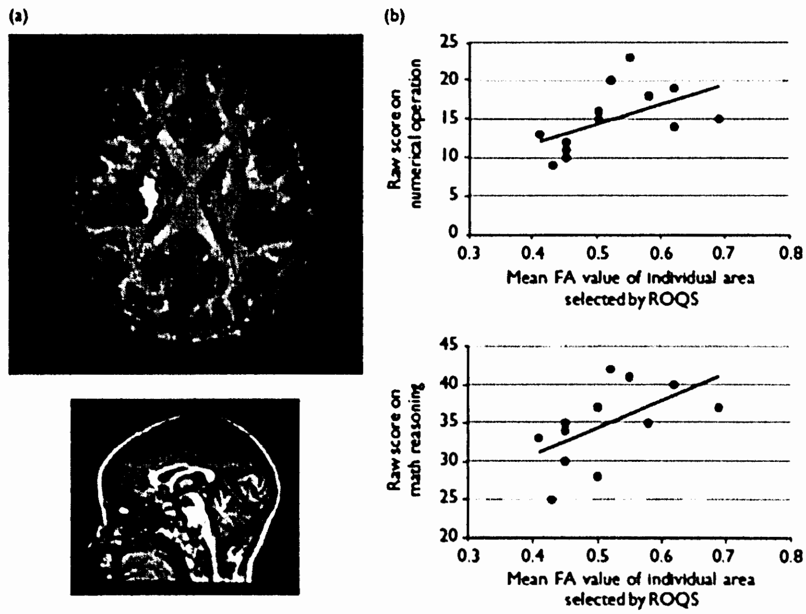


Fig. 2 Relationship of mathematical performance and white matter microstructure fractional anisotropy (FA) in the left superior corona radiate (SCR). (a) Example of a Reproducible Objective Quantification Scheme (ROQS) region of interest of the left SCR. (b) Scatter plots showing relationship between raw scores on the two mathematical tests and the FA values of the left SCR.

Figure 15. Math achievement correlates with white matter. Van Eimeren, Miogi, N., McCandliss, B. D., Holloway, Ian D., & Ansari, D., White matter microstructures underlying mathematical abilities in children, *Cognitive Neuroscience and Neuropsychology*. 2008, 19: 1117-1121, by permission of Wolters Kluwer Health provided by Copyright Clearance Center (CCC).

Ansari (2009) further explains implications of these research findings of differences in neurological development of mathematical ability in struggling students with and without SLD. Functional and structural deficits in mathematical calculations and problem solving do not occur within specific regions of the brain. Ectopias abnormalities occur in multiple neural circuits within both left and right hemispheres of the brain. Therefore, struggling students with and without SLD in mathematics exhibit disorganized white matter tracks similar to struggling students with and without SLD in reading and writing.

The relationship between cognitive processing deficits and poor math calculations and/or problem solving implicates a need for effective instructional interventions and accommodations for academic learning. Mathematical disability correlates more heavily with fluid reasoning (*Gf*) for problem solving skills (Dehn, 2006; Flanagan, Ortiz, & Alfonso, 2007; U.S. Department of Education, 2004a), and more moderately with visual processing (*Gv*) only at the upper levels of math such as geometry and calculus.

Cognitive processes related to math include: crystallized intelligence (*Gc*), subtests of language development (*Gc-LD*), subtests of lexical knowledge (*Gc-VL*), subtests of listening ability (*Gc-LS*; Flanagan, Ortiz, & Alfonso), processing speed (*Gs*), visual processing (*Gv*), fluid reasoning (*Gf*), and short-term memory (*Gsm*; Dehn, 2006; Flanagan, Ortiz, & Alfonso; U.S. Department of Education, 2004a).

Differences and potential growth of specific neurological systems associated with academic learning for struggling students with and without SLD establish the need for enriched learning environments to improve cognitive ability and academic skills. Linking CHC cognitive abilities to academic learning to establish specific needs of struggling students with and without SLD implicates possible recommended instructional interventions and accommodations to provide an enriched environment necessary for nurturing neurological growth. The provision of an ability-oriented evaluation is needed to identify patterns of strengths and weaknesses to determine student needs for recommendations that improve student performance in academic learning.

Cognitive processing ability and achievement skill deficits associated with a learning disability occur exclusionary of limited instruction, specific linguistic weaknesses, limited cultural experiences, or poor motivation (Mather & Wendling, 2005). Therefore, CHC cognitive assessment of the relationship between cognitive ability factors and academic learning provides insight into a deeper understanding of how strengths and weaknesses affect student performance.

Linking CHC Theory of Cognitive Abilities to Academic Learning

Research reveals a correlation of significant variance between cognitive ability and achievement affecting academic learning. CHC theory portrays that cognitive and academic abilities are shaped by environmental experiences. Factors of cognitive ability, the multi-dimensions of human intelligence, are interrelated with academic abilities (Dehn, 2006; Flanagan, Ortiz, & Alfonso, 2007; McGrew, 2005). These complex relationships form the patterns of strengths and weaknesses in cognitive ability and achievement experienced by children with SLD, which implicate academic learning ability.

Implications for Academic Learning

Mather and Wendling (2005) explain the complex relationships between each of the general intelligence ability factors and areas of achievement and implications for academic learning ability. Crystallized Intelligence (*Gc*) has a strong and consistent relationship to the achievement areas of basic reading, reading comprehension, math calculations, math problem solving, written expression, oral expression, and listening comprehension. This relationship implicates academic learning ability related to vocabulary knowledge such as learning vocabulary, answering factual questions, and comprehending oral/written language. The development of these academic abilities is highly predictive of academic success.

Long-Term Retrieval (*Glr*) has a significant relationship to the naming facility of the achievement areas of basic reading, reading fluency, written expression, and oral expression. This relationship implicates academic learning ability, especially during early stages of skill acquisition such as organizing for retrieval, strategies for recall, and learning and retrieving information.

Short-Term Memory (*Gsm*) has a significant relationship to the achievement areas of basic reading, reading comprehension, math calculations, written expression, oral expression, and listening comprehension. This relationship implicates working memory ability and academic learning ability related to attaining knowledge ability such as attending and following directions, recalling sequences, memorizing actual information, listening and comprehending, and taking notes.

Fluid Reasoning (Gf) has a significant relationship to the achievement areas of higher level skills in reading comprehension, math calculations, math problem solving, and written expression. This relationship implicates higher level skill development in academic learning such as problem solving, drawing inferences, mental flexibility, transferring and generalizing, and thinking conceptually.

Auditory Processing (Ga) has a significant relationship to the phonetic coding of basic reading written expression and listening comprehension. This relationship implicates academic learning ability, especially during early stages of skill acquisition such as acquiring phonics, sequencing sounds, listening, learning foreign language, and musical skills.

Processing Speed (*Gs*) has a significant relationship to basic reading, reading comprehension, reading fluency, math calculations, math problem solving, written expression, oral expression, and listening comprehension. This relationship implicates academic learning ability, especially during early stages of learning such as completing assignments on time, processing information quickly, taking timed tests, and copying from the board.

Visual Processing (*Gv*) has some relationship to the visual memory of Reading Fluency and higher level advanced math calculations and problem solving. This relationship implicates academic learning ability such as using patterns and designs, sensing spatial orientation and boundaries, and noting visual detail (Mather & Wendling, 2005).

Linking Cognitive Ability Factors to Achievement

Floyd, Bergeron, and Alfonso (2006) demonstrated this relationship between cognitive ability and academic learning in a study that revealed cognitive ability profiles of poor comprehenders, as portrayed in Figure 16. The participants were children in the second through twelfth grades randomly selected from the WJIII United States standardized sample. Three groups of children consisted of: poor comprehenders, which included 28 children (13 girls and 15 boys) ages 7 to 18; low achievement group, which comprised of 30 children (13 girls and 17 boys) ages 8 to 18; and average achievement group, which contained 323 children (145 girls and 178 boys) ages 7 to 18.

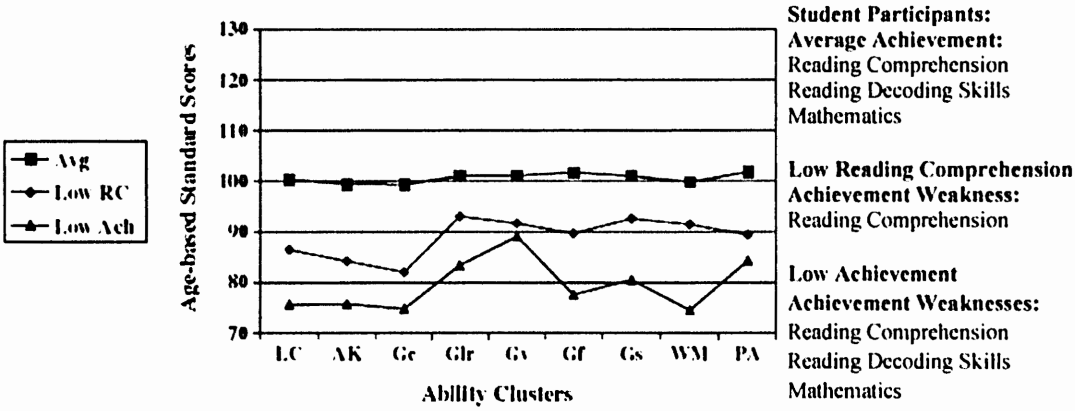


Figure 16. CHC cognitive ability profile of poor comprehenders. Cognitive profiles of the Average Achievement group, poor comprehenders, and the Low Achievement group. LC=Listening Comprehension, AK=Academic Knowledge, Gc=Comprehension–Knowledge, Glr=Long-Term Retrieval, Gv=Visual– Spatial Thinking, Gf=Fluid Reasoning, Gs=Processing Speed, WM=Working Memory, PA=Phonemic *Awareness. With kind permission from Springer Science+Business Media: Reading* and Writing, Cattell-Horn-Carroll Cognitive Ability Profiles of Poor Comprehenders, 2006, 19, 427-456, Floyd, R. G., Bergeron, R. & Alfonso, V. C., Figure 1.

Poor comprehenders in reading contrasted children with effective reading and mathematics skills and children with poor reading and mathematics skills for their age. Group profiles showed that poor comprehenders scored lowest in comprehension-knowledge, academic knowledge, and listening comprehension. They also scored low in fluid reasoning, phonological awareness skills, verbal working memory, and visual-spatial abilities. The correlation of cognitive ability weaknesses linked with achievement weaknesses implicate student needs for enriched learning environments for effective instructional interventions to improve student performance for students with SLD (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Wendling & Mather, 2009).

Ability-Oriented Evaluation

The goal of an assessment for special education services needs to be focused on developing an education plan to improve student performance for students with SLD rather than determination of eligibility services (Heller, Holtzman, & Messick, 1982; Reschly, 1992). The provision of an ability-oriented evaluation is needed to improve student performance in academic learning for students with SLD. An ability-oriented evaluation consists of assessment that focuses on understanding a student's cognitive ability to process information in the form of cognitive ability factors that facilitate academic learning. These cognitive process abilities are interrelated with academic abilities. Therefore, the design of an ability-oriented evaluation helps formulate the problem of a prescriptive hypothesis based on CHC theory and determine specific instructional interventions and accommodations (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling, 2005; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009).

Recommendations Based on the Link of Cognitive Ability to Achievement

These general intelligence (*G*) factors have been linked to academic difficulties experienced by children with SLD. An ability-oriented evaluation consists of assessment that focuses on understanding a student's cognitive ability to process information and includes CHC factors that facilitate academic learning. A learning disability is caused by inherent weaknesses underlying cognitive processes. These cognitive process abilities are interrelated with academic abilities. Therefore, the ability-oriented evaluation formulates the pattern of strengths and weaknesses to determine specific instructional interventions and accommodations to meet student needs (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling, 2005; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009). This descriptive hypothesis provides the educational diagnostician with implications for evidence-based recommendations to provide an enriched environment for the improvement of student performance.

Instructional Interventions

Instructional interventions are specific evidenced-based instructional practices designed to help support the relationship between cognitive ability factors and academic learning. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3). Evidence-based practices are successful research-based instructional teaching strategies based on teaching principles.

Principals of instructional interventions. Wendling and Mather (2009) identified 10 effective teaching principles of evidence-based practices: (1) actively engage students in instructional talks; (2) build-in success for student learning outcomes; (3) increase opportunities to learn; (4) provide direct instruction; (5) scaffold instruction to build independent; (6) self-regulating learners; (7) address forms of knowledge such as declarative knowledge, procedural knowledge, and conditional knowledge; (8) assist learning by organizing, storing, and retrieving knowledge, teach strategically to build independent, self-regulated learners; (9) explicit instruction also builds independent, self-regulated learners; and (10) teach sameness of how things are alike within and across subjects (p. 7). Increasing diversity of students being served in general educational classrooms has encouraged teachers to use instructional practices that enhance the performance of groups of students, as well as individual students to meet student needs for academic learning.

Criteria for selecting instructional interventions. Evidence-based instructional interventions that improve academic learning assist students in meeting learning standards by promoting academic productivity and achievement (Rathvon, 2008). Rathvon identified specific criteria for selecting instructional interventions: (1) provide interventions that are documented evidence of effectiveness, (2) focus on the student deficits consistent with student needs, (3) emphasize a proactive approach for manipulating antecedents that modify the environment to promote high levels of student engagement, (4) present interventions that are applicable to the whole class to meet the needs and diversity of the student population, (5) offer interventions that are capable of being easily taught as opposed to high demands on teacher time, (6) give interventions that can be delivered using general education classroom resources, and (7) provide interventions that result in concrete and observable student behaviors that can be objectively measured by reliable, valid and practical methods over time.

The instructional interventions provided in the *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) meet these criteria to meet student needs for improving academic performance. Instructional interventions provide multiple means of representation, expression, and engagement (Nolet & McLaughlin, 2000). Dehn (2008), Mather and Wendling (2005), Wendling and Mather (2009), and Rathvon recommended the following evidence-based recommended instructional interventions related to the relationship between cognitive ability normative weakness factors and academic learning.

Crystallized Intelligence (*Gc*) recommended possible instructional interventions to learn new knowledge and vocabulary include: create a language and experience rich environment; relate new information to acquired knowledge; assess prior knowledge before introducing new topics or concepts; provide frequent exposure and practice to words; pre-teach relevant vocabulary/background information; develop word consciousness, the awareness of, and interest in, words and their meanings; provide explicit vocabulary instruction such as the meaning of common prefixes, suffixes, and root words; incorporate interests and prior knowledge experiences into instructional activities; provide clear and concise language when presenting concepts; and check for understanding to ensure comprehension.

Long-Term Retrieval (*Glr*) recommended possible instructional interventions to improve associative memory and retrieval include: teach memory aids such as verbal mediation or rehearsal and mnemonic strategies; provide over-learning through review and repetition; provide a list of steps that will help organize learning behavior and facilitate recall; provide multisensory learning using visual, kinesthetic, vocal, and auditory channels; emphasize concept mastery understood instead of rote memory for rote information in grading rubrics; check to ensure that the student has retained sufficient information for independent work; and provide immediate feedback.

Short-Term Memory (*Gsm*) recommended possible instructional interventions to increase retention of plans for formation, transformation, or execution include: teach strategies to increase understanding and retention of concepts such as self talk, and create lists of procedures or steps; teach memory strategies such as chunking, verbal rehearsal, and visual imagery; gain the student's attention before stating a direction; encourage asking for directions or information to be repeated if not understood or remembered; keep oral directions short and simple; have the student repeat or paraphrase directions; provide visual aids such as written directions for assignments; provide over-learning through review and repetition; check understanding of concepts through practice and talk-alouds; and provide immediate feedback.

Fluid Reasoning (*Gf*) recommended possible instructional interventions to extend and refine knowledge include: teach problem-solving techniques in the contexts in which they are most likely to be applied; provide over-learning through repetition and multiple review of concepts; use concrete objects and manipulatives to develop conceptual understanding; use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques; use think-alouds, guided practice, and feedback; use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, and analyze perspectives; and monitor for understanding.

Auditory Processing (*Ga*) recommended possible instructional interventions to improve processing of auditory stimuli and phonological awareness include: provide direct explicit, systematic instruction; provide phonological awareness activities such as rhyming, alliteration, imitation, and songs; provide explicit, instructions in sound discrimination, blending, and segmentation; emphasize sound-symbol associations when teaching decoding and spelling; provide visual aids, such as notes or study guides for listening activities, and provide assistance with note taking; accompany oral information with visual materials; and check for comprehension after directions are given.

Processing Speed (*Gs*) recommended possible instructional interventions to improve slow processing include: provide oral discussions; provide activities to increase rate and fluency, such as flash cards or speed drills through educational software; provide strategies that improve the rate of task completion; and encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency.

Visual Processing (*Gv*) recommended possible instructional interventions to improve spatial relations, visualization, visual memory, closure speed, and spatial scanning include: provide multisensory learning using visual, kinesthetic, vocal, and auditory channels; use manipulatives during instruction; use language to describe visual forms of information as they are manipulated; provide copying, tracing, and drawing activities; provide verbal description of graphics and visually-based concepts; and use color coding to illustrate steps.

The use of evidenced-based instructional intervention enriches environmental influences to nurture neurological growth for developing the relationship between cognitive ability factors and academic learning. The provision of optimal support with specific instructional interventions related to specific cognitive ability factor weaknesses provided during academic instruction encourages cyclical, neurological, and cognitive growth in skill level development, which strengthens both cognitive ability and academic performance through the development of single abstracts into abstract mapping, abstract systems, and principals. The strengthening of this relationship improves student performance in academic learning.

Accommodations

Accommodations provide support that helps the student access instruction and curriculum for academic learning. Instructional accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71).

Classification of accommodations. Classification of accommodations including presentation accommodations, response accommodations, scheduling/timing accommodations, setting accommodations, and behavior accommodations assists the student with instructional and curriculum support (Gregg & Lindstrom, 2008).

Presentation accommodations provide access to academic information through alternative means such as oral presentation, screen reader, assess assistance, and sign language interpreter; alternative media such as e-text, audio books, and Braille; language structures such as simplified language, font format such as large print and type or color of font; and instructional methodology such as cooperative learning and computer-assistance.

Response accommodations support demonstration of knowledge such as alternative forms, which include oral response; accessing assistance such as providing a scribe and text-to speech assistance; and assistive technologies such as voice-to-text, use of a word processor, and use of a calculator. Setting accommodations support academic environment alterations such as private room and small group. Schedule/Time accommodations support adjustments to time provided such as additional time to complete learning tasks, respond to academic content, and extended time. Behavior accommodations facilitate appropriate behavioral responses for academic learning, such as breaking tasks down into smaller unites and reinforcement systems (Gregg & Lindstrom).

The provision of accommodations specific for presentation, response, setting, and schedule/time allow student access to instruction and curriculum for improved student progress. The accommodations provided in the *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) meet these specific student needs for improving academic performance. Dehn (2008), Mather and Wendling (2005), Wendling and Mather (2009), and Rathvon (2008) recommend the following evidence-based recommended accommodations related to the relationship between cognitive ability normative weakness factors and academic learning.

Crystallized Intelligence (*Gc*) recommended possible accommodations for learning new knowledge and vocabulary include: provide resources to help students participate in class discussion, provide prompts to enhance written expression, and provide preferential seating to enhance monitoring of comprehension.

Long-Term Retrieval (*Glr*) recommended possible accommodations to improve associative memory and retrieval include: limit the amount of information to be learned during an instructional session, provide reference sheets and/or a calculator during math computation, and use graphic organizers to reinforce associations between concepts.

Short-Term Memory (*Gsm*) recommended possible accommodations to increase retention of plans for formation, transformation, or execution include: provide visual guides during oral presentations, provide lecture notes or arrange for peer-shared notes, provide a study guide to be completed during pauses in presentation, seat the student in a location away from distractions in order to optimize attention, provide extra time to copy information, read written directions aloud; and use graphic organizers to reinforce associations between concepts.

Fluid Reasoning (*Gf*) recommended possible accommodations to extend and refine knowledge include: provide assistance in a timely manner, provide assistance with functions throughout a task such as when there are changes in task demands, seat the student next to a peer helper who can provide assistance, and use graphic organizers to analyze relationships (such as cause and effect, compare and contrast, classification schemes, and sequential order).

Auditory Processing (*Ga*) recommended possible accommodations to improve processing of auditory stimuli and phonological awareness include: provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise, provide a peer assistant or buddy to assist with information when the student does not understand an oral communication, and provide preferential seating that supports monitoring of student comprehension.

Processing Speed (*Gs*) recommended possible accommodations to improve slow processing include: shorten directions; provide lecture outlines such as a formatted script of notes in which only key words need to be added; limit or structure copying activities; consider individualizing test taking, such as small group; provide extra time to read the text; provide extra time for processing; and provide extra time to complete assignments.

Visual Processing (*Gv*) recommended possible accommodations to improve spatial relations, visualization, visual memory, closure speed, and spatial scanning include: provide spatial and sequential guides, provide visual markers to indicate starting location and organization, and provide graphic organizers to organize information.

The use of accommodations based on the relationship between specific cognitive ability factor weaknesses and achievement weaknesses in an optimal supported inclusion classroom builds an interactive learning experience with enriched environmental support. The provision of these accommodations develop stronger neurological systems for academic learning as the access allows opportunity for higher levels of thinking to reflect cognitive development and express academic learning that improves student performance.

Linking CHC to Intervention Tool

The reauthorization of IDEIA (2004) states that one of its purposes is "to ensure that educators and parents have the necessary tools to improve educational results for children with disabilities by supporting system improvement activities; coordinated research and personnel preparation" (p. 5) as well as to assess and ensure the effectiveness of efforts to educate children with and without disabilities. The *Linking*

CHC to Intervention Tool (Proctor & Albright, 2010) assists in the organization and communication of recommendations by directly linking student performance results of an ability-oriented evaluation to improve student performance for children with and without disabilities (see Appendix A).

Regardless of whether a student is identified as having SLD or not, converging evidence and organizing it into the *Linking CHC to Intervention Tool* is an effective way of choosing recommendations. The identification of a student's weaknesses and its association with specific learning problems should involve confirmed difficulties documented and supported by other sources of evidence such as school records, curriculum-based measurement, work samples, observations, and diagnostic interviews.

An analysis of this convergence of evidence provides a framework for recommending interventions for the remediation of cognitive and/or academic difficulties and/or accommodations to access compensating skills to manage them. Committee decisions for developing recommendations are justified by supporting them with results of student assessment and data collection. Determination of the most appropriate context for application, schedule, and intensity of the recommendations stems from a clear understanding of the data (Flanagan & Mascolo, 2005). The *Linking CHC to Intervention Tool* provides possible interventions and accommodations applicable to meeting the needs of weaknesses associated in assessment results of both cognitive processing abilities and achievement skills.

The *Linking CHC to Intervention Tool* can be used to organize students' cognitive and academic profiles in a manageable way. Furthermore, collaborative efforts between assessment personnel, parents, special educators, general educators, and administrators can justify student needs to improve student performance based on assessment results through the use of the *Linking CHC to Intervention Tool*. When recommendations are written into the student's individual education plans (IEPs), the student's present learning, future environments, and curricular demands are considered. Instructional and accommodation provisions for the remediation and compensation of assessment results provide students with life-long learning abilities and skills that they can pass on intergenerationally. Therefore, this enriched learning environment will impact improved student performance for future learners.

The *Linking CHC to Intervention Tool* provides educational diagnosticians, teachers, and parents with a quick view of the: (1) definition of each general intelligence factor of cognitive ability according to CHC theory, (2) general intelligence factor related achievement normative weaknesses, (3) relationship of each general intelligence factor to academic learning, and (4) recommended evidenced-based instructional interventions and accommodations based on CHC theory. The *Linking CHC to Intervention Tool: Procedures for Documenting and Summarizing the Assessment Results and Recommendations* (Proctor & Stephens, 2010) provides educational diagnosticians with guidelines for filling out the *Linking CHC to Intervention Tool,* as seen in Appendix B.

CHAPTER III

METHODOLOGY

This study examined to what extent educational diagnosticians, who are professional educational diagnosticians, possess knowledge on the relationship between academic learning and cognitive ability factors and to what extent they recommend possible interventions and accommodations related to the relationship between academic learning and cognitive ability factors. This study used a quasi-experimental mixed model methodology, which was organized into two phases. The first phase consisted of a quantitative descriptive design using survey methodology. A Likert scale instrumentation rated acquired skills for linking the relationship of CHC cognitive ability and academic learning on a 1-5 scale rating from "low" to "high", and extent of recommending instructional interventions and accommodations on a 1-5 point scale rating from "never" to "always".

The second phase of the study consisted of a qualitative design utilizing focus group methodology. A Likert scale instrumentation used a 1-7 point scale rating from "not very important" to "very important" to answer how educational diagnosticians perceive their quality of training and preparation, and what barriers they encounter when linking Cattell-Horn-Carroll (CHC) theory to academic learning.

The study design was submitted and approved by the Institutional Review Board (IRB) for Human Research Protection and met requirements for the protection of individual's rights (see Appendix C). This chapter delineates (a) the purpose of the study, (b) the research questions, (c) assumptions, (d) a description of research participants, (e) the data collection procedures, and (f) the data analysis procedures.

Purpose of the Study

The purpose of this research study was four-fold: (1) to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory, and (4) to determine educational diagnosticians' perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in CHC theory.

This study design used a quasi-experimental mixed model methodology, which was organized into two phases. The first phase of this study was a descriptive quantitative design utilizing survey methodology. The second phase of the study was a qualitative design utilizing focus group methodology.

Research Questions

This study sought to answer the following four research questions:

1. To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to cognitive ability factors?

2. To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to cognitive ability factors?
3. To what extent do educational diagnosticians recommend accommodations related to the relationship of academic learning to cognitive ability factors?
4. What are educational diagnosticians' perceptions regarding the quality of training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory?

Assumptions

This study assumed that the attitudes of educational diagnosticians influenced their choice of recommending instructional interventions and accommodations based on the relationship of CHC cognitive ability factors and academic learning. This study also assumed that the participants honestly responded to survey and focus group questions.

Quantitative Phase

Purpose of the Quantitative Phase

The purpose of the quantitative phase was three-fold: (1) to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, and (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory.

Instrumentation

The instrument used in the quantitative phase was a survey, *Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations*. In the process of developing the instrument, a thorough literature review was conducted regarding the link between cognitive ability factors and academic learning based on CHC theory and possible recommendations related to this link between cognitive ability factors and academic learning. A Likert scale instrumentation rated acquired skills for linking the relationship of CHC cognitive ability and academic learning on a 1-5 point scale rating from "low to high", and extent of recommending instructional interventions on a 1-5 point scale rating from "never" to "always" (see Appendix D).

Participants

Survey participants consisted of current educational diagnosticians who professional educational diagnosticians. Permission from the professional educational diagnosticians organization was considered and granted during the January 30th board meeting in Austin, Texas (see Appendix F). The organization proclaims that "all registered members . . . have a master's degree, certification as an Educational Diagnostician, classroom experience as a teacher for at least two years, practiced as an educational diagnostician at least two years and recommendations from five persons. Registration assures: professional experience, professional endorsements by peers, supervisors and consumers, successful completion of a competency examination, and excellence above a level of competence" (Texas Professional Educational Diagnosticians, 2010, p. 1).

Educational diagnosticians were asked to participate in the completion of the survey *Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations*. The following statement was included on the survey for informed consent and voluntary participation in the survey: "I understand that the return of my completed survey constitutes my informed consent to act as a participant in this research."

An email directory of all professional educational diagnostician members was provided by the organization. Members were recruited by email and invited to participate. The email provided information regarding the purpose of the study, the survey link, and directions for accessing the survey online. Educational diagnosticians were asked to participate in a focus group upon completion of the survey (see Appendix F). Participation in the survey and focus group was voluntary.

The focus group participants were randomly selected from survey participants who volunteered to participate in the focus group meeting. Five participants, who were professional educational diagnosticians, completed survey, indicated their choice for participation in the focus group, and provided contact information. They were provided a consent form. Code names were assigned to protect the identity of focus group participants. Any identifying information was omitted from the field notes.

Data Collection Procedures

The quantitative phase used an online survey for data collection to determine the validity of significant variables generated in survey research. The survey was distributed via online through PsychData to professional educational diagnosticians. The link to the survey was made available for approximately three weeks to allow participants ample time to respond during their leisure time.

Demographic information was collected in the first section of the study. The second section consisted of a survey. A Likert scale approach was designed to investigate professional educational diagnosticians' acquired knowledge of linking the relationship of Cattell-Horn-Carroll (CHC) theory of cognitive ability and academic learning, and extent of recommending possible instructional interventions and accommodations based on this relationship between cognitive ability and academic learning. Three survey statements were developed with intent to address the first, second, and third research questions for this phase of the study. The survey statements address each of the seven cognitive ability factors. Research questions and their related survey statements were as follows:

Research Question 1. To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to the cognitive ability factors?

Survey Question 1. I perceive my level of knowledge regarding the relationship of the general intelligence factor (G) to academic learning as: low, somewhat low, moderate, somewhat high, and high.

Research Question 2. To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to cognitive ability factors?

Survey Statement 2. Please indicate the extent to which you recommend the following possible instructional interventions related to the general intelligence factor (c): never, rarely, sometimes, often, and always.

Research Question 3. To what extent do educational diagnosticians recommend accommodations related to the relationship of academic learning to cognitive ability factors?

Survey Statement 3. Please indicate the extent to which you recommend the following possible accommodations related to the general intelligence factor (G): never, rarely, sometimes, often, and always.

Participants were posed five choices as noted. After the data was collected, each choice was assigned a number from one to five. The data measuring acquired knowledge of linking the relationship of CHC theory of cognitive ability and academic learning used one to indicate "low", two to indicate "somewhat low", three to indicate "moderate", four to indicate "somewhat high", and five to indicate "high" levels of knowledge. The data measuring the extent to which professional educational diagnosticians recommend possible instructional interventions and accommodations used one to indicate "never", two to indicate "rarely", three to indicate "sometimes", four to indicate "often", and five to indicate "always" recommend instructional interventions and accommodations.

Data Analysis

Quantitative data analysis consisted of descriptive statistics and a cross tabulation X^2 test Statistical Package for Social Scientists (SPSS) software. The independent variables in this study consisted of the following demographic variables: (1) current position, (2) level of education, (3) period of educational diagnostician certification, (4) years of educational diagnostician experience, (5) district requirements for initial evaluations, (6) professional development focusing on linking CHC theory to academic learning, (7) educational diagnostician preparation program courses on linking CHC theory of cognitive ability to academic learning, (8) educational diagnostician certification program preparation, (9) mode of delivery, (10) gender, (11) ethnicity, (12) school district (urban, suburban, rural), and (13) regional Educational Service Center area.

The dependent variables in this study were clustered within the following definable groups: (1) knowledge of the relationship between each of the seven cognitive ability factors and academic ability, (2) extent of recommending instructional interventions related to the relationship between academic learning and each of the seven cognitive ability factors, and (3) extent of recommending accommodations related to the relationship between academic learning and each of the seven cognitive ability factors. The seven cognitive ability factors include: (1) Crystallized Intelligence (*Gc*), (2) Long-Term Retrieval (*Glr*), (3) Short-Term Memory (*Gsm*), (4) Fluid Reasoning (*Gf*), (5) Auditory Processing (*Ga*), (6) Processing Speed (*Gs*), and (7) Visual Processing (*Gv*).

Responses from the survey were analyzed using descriptive statistics and a cross tabulation X^2 test using Statistical Package for Social Scientists (SPSS) software. Descriptive statistics was used to organize the demographic information. A cross tabulation X^2 test was utilized to determine statistical significance between the set of dependent variables and the set of independent variables. In addition, Cronbach's Alpha was utilized to determine inter-reliability of each instructional intervention and each accommodation based on the extent educational diagnosticians' recommend instructional interventions and accommodations related to the relationship of academic learning to each of the cognitive ability factors.

Qualitative Phase

Purpose of the Qualitative Phase

The second source of data was a focus group. The purpose of the qualitative phase was to clarify how professional educational diagnosticians acquired knowledge of linking the relationship between cognitive ability factors and academic learning, and their recommendations of instructional interventions and accommodations.

Focus Group Question Development

Five focus group questions, two two-part and one one-part, were developed to obtain information about educational diagnosticians' knowledge of linking the relationship between cognitive ability factors and academic learning, and their recommendations of instructional interventions and accommodations. The five focus group questions were developed with intent to address the fourth research question for this phase of the study. Each focus group question was preceded by a prompt. Research question four and its related focus group prompts and questions were as follows:

Research Question 4. What are educational diagnosticians' perceptions regarding the quality of their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory?

Focus Group Prompt 1A. Federal and State law requires that the identification of SLD only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

Focus Group Question 1A. Think back on the variety of ways you acquired knowledge and skills on the relationship between cognitive ability factors and academic learning reflected in the CHC theory. How did you acquire the knowledge and skills for linking cognitive ability factors with academic learning?

Focus Group Prompt 1B. You just described the specific learning experiences that help you link the relationship between cognitive ability factors and academic learning.

Focus Group Question 1B. What would have better prepared you to link the relationship between cognitive ability factors and academic learning?

Focus Group Prompt 2A. Federal and State law requires that the identification of a SLD only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3).

Focus Group Question 2A. Think back on the variety of ways you acquired knowledge and skills of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible instructional interventions do you currently recommend based on CHC theory?

Focus Group Prompt 2B. Federal and State law requires that the identification of SLD only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. These accommodations provide support that helps the student access instruction and curriculum for academic learning. Accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71).

Focus Group Question 2B. Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible accommodations do you currently recommend based on CHC theory?

Focus Group Prompt 3. Federal and State law requires that the identification of SLD only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

Focus Group Question 3. Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What barriers do you encounter when linking CHC theory to academic learning?

Focus Group Participants

Professional educational diagnosticians were invited to participate in the focus group. The recruitment process for inclusion in a focus group was facilitated through the survey. The following statement was included on the survey for recruitment of focus group participants: "If you are an educational diagnostician in the State of Texas, and you would be willing to participate in a 60 to 90 minute focus group activity, please provide contact information so that a consent form can be provided."

Five participants who returned the completed survey, and who indicated their choice for participation in one of the focus groups with a "Yes", were provided a Consent to Participate in Research form for participation in the focus group (see Appendix G).

Focus Group Setting

Focus group participants met in a conference room in the Dallas ISD. A focus group was held during available times after the educational diagnostician's work hours. Permission to use the conference room for the focus group was obtained from the director of Individual Evaluation and the supervisor of educational diagnosticians of the department of Special Education of Dallas ISD (see Appendix H).

Focus Group Measures

Two types of measurement systems were used to measure participants' responses. The first measure included written responses of participants gathered during the focus group meeting and categories of responses generated by participants and moderator, which was the primary researcher. Second, the Focus Group Questions, which included individual participant rating and voting measures, were utilized to verify the importance of each category generated by the group (see Appendix I).

Written response. The moderator stated each focus group prompt and asked each focus group question. The focus group participants recorded their individual responses on three by five inch color-coded sticky note cards using statements of seven words or less if possible. These sticky note-cards were clustered into sets of common traits by the participants and moderator. Each set of note-cards was given a categorical label determined by the participants.

Voting and rating sheets. Five rating and voting sheets were developed that corresponded with research question four, which were discussed during the focus group meeting. Each rating and voting sheet had a two-part design. The purpose of the first part of each measurement sheet was to validate individual participant's perception of the importance of each category that had been generated by the group. After the categories were established, participant volunteers recorded each category on provided lines. A seven-point Likert scale with number values ranging from one as "not very important" to seven as "very important" were located to the right side of each line provided for the recording of each category. Participants circled a number according to how they rated the category when considering importance of the category.

The purpose of the second part of each measurement sheet was for the moderator to determine the most important categories for each question according to participants' votes. Blank lines were provided for participants to list their top choices from among the total set of categories. Participants were requested to vote for one-half of the most important categories (e.g., if the group had six categories, they were asked to vote for the three categories they valued most).

Metaplan Meeting and Agenda Procedures

The lead researcher, as the moderator, opened the meeting with a warm welcome, introduction of the lead researcher as the moderator and participant volunteers; reviewed of the purpose of the meeting; and explained the importance of maintaining confidentiality for anything shared during the meeting. Written consent was obtained from all participant volunteers. Individual pocket folders were passed out to each participant that included the following items: Focus Group Discussion Protocol, five color-coded rating and voting sheets, the *Linking CHC to Intervention Tool* (Proctor & Albright, 2010), and the *Linking CHC to Intervention Tool: Procedures for Documenting and Summarizing the Assessment Results and Recommendations* (Proctor & Stephens, 2010). Five sets of color-coded sticky note-cards were distributed. The sticky note-cards' colors corresponded to each of the five color-coded rating and voting sheets.

Next, the moderator led the group of participants in reading and discussing the Focus Group Discussion Protocol (see Appendix J). During this time, concepts of the importance of linking the relationship of CHC cognitive ability factors to academic learning was highlighted, and possible recommendations of instructional interventions and accommodations based on the linking of CHC cognitive ability factor to academic learning was emphasized. The Metaplan Steps (Schnelle & Schnelle, 1973) were presented, as listed in Table 3.

Table 3

The Metaplan Process

Step	Question
Step 1	A question is stated.
Step 2	Participants write thoughts and feelings on note cards.
Step 3	Participants write clearly and neatly.
Step 4	Write one idea per card.
Step 5	Use 7 words or less if possible
Step 6	The moderator collects and reads note-cards aloud and displays them on the wall.
Step 7	The moderator, with participants' assistance, organizes the note cards into clusters or categories of thoughts, feelings, and opinions.
Step 8	Participants may continue writing their thoughts during the clustering process.
Step 9	The moderator and participants discuss their thoughts, feelings, and ideas through the clustering process.
Step 10	The participants conclude the process by rating the categories according to how important they perceive them to be. They also rank their top categories according to perceived importance.

After the steps were presented, the moderator modeled how participants were to record their responses. During the modeling, the moderator demonstrated asking the participants to write down as many characteristics as they could think of that described their favorite learning environment. The moderator, modeling for participants, wrote her responses of up to seven words each on sticky note-cards. During the modeling, the moderator used the *Think-Out-Loud* instructional strategy as she wrote the responses onto the sticky note-cards. When she finished, the moderator read each of the responses. With the participants' help, the moderator began clustering responses into definable groups on a large presentation note pad.

Once the modeling was concluded, the focus group questions were posed. Time was provided for participants to record responses and complete the focus group member rating and voting process. The following sequence of events occurred for each question posed during the focus group meeting.

Recoding, voting, and rating of participants' responses. Participants recorded their individual written responses of up to seven words individually on three by five inch color-coded sticky note-cards. The recorded statements were reactions to particular questions that were posed by the group moderator. As the participants recorded their responses, the moderator collected the responses and posted them on the large presentation white dry-erase board, which served as the data collection center. The note-cards were individually read by the moderator and were clustered into similar sets by participants and the moderator. Each clustered group of the note-cards was given a name, which served as the categorical label. The categorical labels were also written on the large presentation white board using related color-coded dry-erase markers for each clustered group of note-cards.

In addition to clustering the note-cards, participants were directed to complete the Focus Group Member Rating and Voting Sheet. First, participants wrote each category onto their rating and voting sheets. Then, the participants rated each category individually on a Likert scale of one to seven as to the importance of the category. Second, participants were instructed to vote for one-half of the categories that they felt were most important. After all the questions were posed and the participants voted, the meeting ended with closing remarks, thanks, and appreciation from the moderator for the group's participation in the research project.

Data collection procedures. Qualitative data analysis consisted of group ranks, mean ratings, and standard deviations for each generated category of written comments by focus group participants. Information was transcribed from field notes and categories of sorted responses, which were established during the Metaplan process. The Metaplan process is a facilitation method and communication model for groups of people, in which opinions are developed to build a common understanding for optimal problem solving. Objectives, recommendations, and action plans are formulated by the participants to focus on a problem and possible solutions (Schnelle & Schnelle, 1973). The primary investigator as the moderator and participants reviewed the field notes to clarify meaning and identify keywords and phrases for common themes. These thematic responses were sorted into categories during the focus group discussion. The outcomes of the qualitative data were reported in the form of a narrative description to reveal what specific educational diagnosticians perceive to be the quality of their training and/or preparation programs, and knowledge on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll theory.

Data analysis. The data collected from the results of each individual participant's rating and voting sheets were documented on the Focus Group Results form for calculating group results. Data analysis consisted of ranking the top four most important categories based on the group total of each individual participant's ranking of each of the categories. From the rating sheets, a mean rating was calculated for each category by tallying the number values the participants circled for a particular category, and dividing the total number by the number of persons who had responded. Next, standard deviations were calculated for each of the individual categories.

Following the focus group meeting, the moderator analyzed the rating and voting sheets. A tally mark systemization process was utilized to determine how each participant ranked his/her choice of top categories determined by the group. Each time a category appeared on a participant's voting sheet, a tally mark of the number one was marked for each category on the Focus Group Results data collection form. The category with the most tally marks received the group rank of one; the next category with the highest number received the group rank of 2; and so forth (see Appendix K).

CHAPTER IV

RESULTS

The purpose of this research study was four-fold: (1) to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory, and (4) to determine educational diagnosticians' perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. The results section provides a description of the research findings. Participant demographic data and analysis of the research questions are presented through a quantitative perspective (Quantitative Phase). Focus group findings and analysis of the related research question are presented through a qualitative perspective (Qualitative Phase). A summary of the results follows.

Quantitative Phase

Purpose

The purpose of the quantitative phase was three-fold: (1) to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, and (3) to determine to what extent educational diagnosticians recommend accommodations based on CHC theory. An online survey was completed by 42 participants who were professional educational diagnosticians.

Survey Participants

Survey participants consisted of current professional educational diagnosticians. The organization proclaims that "all registered members . . . have a master's degree, certification as an Educational Diagnostician, classroom experience as a teacher for at least two years, practiced as an educational diagnostician at least two years, and [has] recommendations from five persons. Registration assures professional experience; professional endorsements by peers, supervisors, and consumers; successful completion of a competency examination; and excellence above a level of competence" (Texas Professional Educational Diagnosticians, 2010, p. 1).

A total of 56 participants started the survey instrument, and 42 completed all 21 questions. The organization of professional education diagnosticians membership consisted of approximately 500 active members; therefore, the 42 participants represented 8.4 percent of member population. In addition, the 42 participants serviced districts from 12 of the 20 Regional Education Service Centers, which represented 60 percent of Regional Education Service Center areas of Texas. For the purpose of this study, the 42 participants who competed the survey instrument were used for demographic and analysis of the data collection.

Frequencies and percentages were collected to identify participants' educational diagnostician assignments (see Table 4). Most participants served all grade levels at either elementary, middle, or high school levels. However, more participants reported having educational diagnostician assignments only in elementary schools than only in middle or high schools respectively. 28.5% of the population served all district grade levels including elementary, middle, and high schools.

Table 4

Frequency and Percent of Population for Participants' Assignments

Assignments	N	%
Pre-K - 5th Grade	11	26.2
6th - 8th Grade	6	14.3
9th - 12th Grade	4	9.5
Other	21	50.0
Other-All Grade Levels	12	28.6
Other-Pre-K - 8th Grade	1	2.4
Other-K - 6th Grade	1	2.4
Other-ECI/Child Find: 3 years - 1st; 6th - 8th Grade	1	2.4
Other-University Instructor	2	4.8
Other-District Special Education Director	2	4.8
Other-Assistant Director of Special Education	1	2.4
Other-ESL Teacher	1	2.4

Note: ECI= Early Childhood Intervention Services; ESL=English as a Second Language

Frequencies and percentages were collected to identify participants' regional Educational Service Center (ESC) serving the school districts in which participants serve. Regional ESCs and locations are illustrated in Figure 17. Sixty percent of participants served in regional ESCs throughout Texas (see Table 5). The largest population (49.9%) of educational diagnosticians served districts in regional ESCs of North central Texas including: Region 10, Region 11 and Region 12. Districts in East Texas regional ESCs had the next largest population (28.6%) including: Region 4, Region 6 and Region 7. In contrast, significantly smaller populations of participants served districts in North Texas ESCs (4.8%), Region 17; West Texas ESCs (7.1%) , Region 19; and South Texas (9.6%): Region 2, Region 3, Region 13 and Region 20.

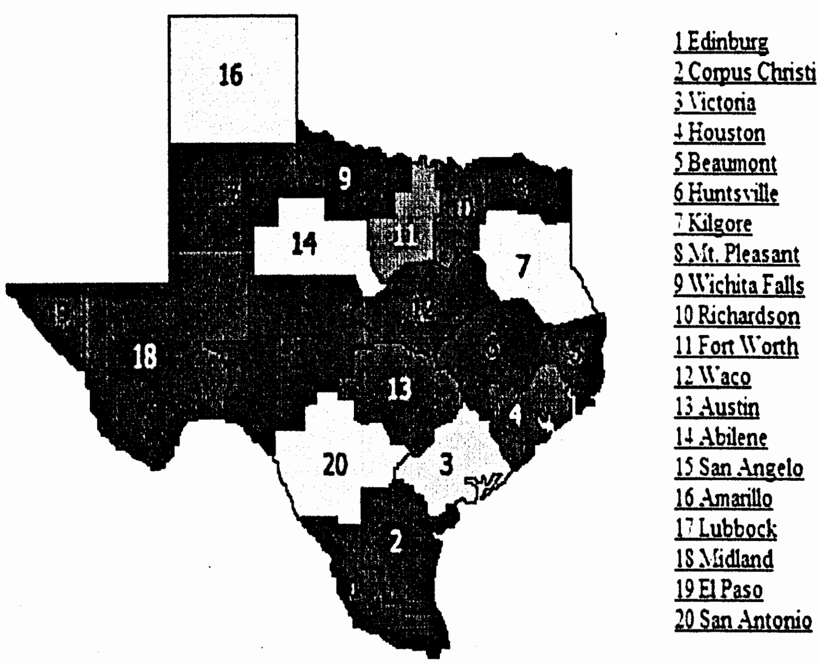


Figure 17. Texas Education Agency: Regional Education Service Centers (ESCs). Retrieved from http://ritter.tea.state.tx.us/ESC

Table 5

Frequency and Percent of Population Serving School Districts in the Texas Regional Educational Service Centers (ESCs)

ESC	Location	N	%
1	Edinburg	0	0.0
2	Corpus Christi	1	2.4
3	Victoria	1	2.4
4	Houston	6	14.3
5	Beaumont	0	0.0
6	Huntsville	2	4.8
7	Kilgore	4	9.5
8	Mt. Pleasant	0	0.0
9	Wichita Falls	0	0.0
10	Richardson/Dallas	10	23.8
11	Fort Worth	8	19.0
12	Waco	3	7.1
13	Austin	1	2.4
14	Abilene	0	0.0
15	San Angelo	0	0.0
16	Amarillo	0	0.0
17	Lubbock	2	4.8

(continued)

Table 5, continued

Frequency and Percent of Population Serving School Districts in the Texas Regional Educational Service Centers (ESCs)

ESC	Location	N	%
18	Midland	0	0.0
19	El Paso	3	7.1
20	San Antonio	1	2.4
Total		12	100

Frequencies and percentages were collected to identify participants' ethnicity and were recorded in Table 6. As noted in Table 6, six options were available to represent the participants' ethnic heritage: "Caucasian," "Hispanic," "African American," "Asian-Pacific Islander," "Native American," and "Other." The ethnicity of the participants was primarily Caucasian, Hispanic, and Hispanic mixtures. Significantly more educational diagnosticians were Caucasian than Hispanic or Hispanic mixtures. In terms of gender, 95.2% of the participants were female and 4.8% were male; therefore, significantly more participants were female compared to male.

Five demographic statements on the survey instrument addressed the participants' education. Frequencies and percentages were collected for the first statement pertaining to education. As seen in Table 7, most of the participants received a master's degree plus post-master's hours compared to some who received a master's degree, and a very few who received a doctoral degree.

Table 6

Frequency and Percent of Population for Participants' Ethnicity

Ethnicity	N	%
Caucasian	39	92.9
Hispanic	1	2.4
Other: Hispanic and Caucasian/Mexican American	2	4.8

Table 7

Frequency and Percent of Population for Level of Education

Education Level	N	%
Master's Degree	14	33.3
Master's Degree plus Post-Master's Hours	25	59.5
Doctoral Degree	3	7.1

Frequencies and percentages were collected for the second statement pertaining to the participants' period of educational diagnostician certification (see Table 8). As seen in Table 8, many participants (26.2%) received their certification between 2000 and 2008, around the time of the No Child Left Behind Act of 2002 (Public Law 107-110) and the reauthorization of IDEIA 2004. Most participants (45.2) received their certification between 1990 and 1999 which was around the time of the reauthorization of IDEA 1997. Fewer participants (16.7%) received their certification between 1980 and 1989, during the Education for All Handicapped Children Act of 1975 (Public Law 94-142). The fewest participants (11.9%) received their certification prior to 1980, around the time of the enactment of Public Law 94-142.

Table 8

Frequency and Percent of Population for Period of Educational Diagnostician Certification

Period of Certification	N	%
2005-2008	2	4.8
2000-2004	9	21.4
1995-1999	10	23.8
1990-1994	9	21.4
1985-1989	2	4.8
1980-1984	5	11.9
Prior to 1980	5	11.9

Frequencies and percentages were collected for the third statement pertaining to the participants' years of educational diagnostician experience (see Table 9). As revealed in Table 9, a very few of the participants (7.1%) had been practicing as an educational diagnostician for two to five years under the reauthorization of IDEIA 2004 (Public Law 108-446). Most participants (38.1%), who had been practicing as an educational diagnostician for 2 to 10 years, began serving districts around the time of the No Child Left Behind Act of 2002 (Public Law 107-110.

Table 9

Frequency and Percent of Population for Years of Educational Diagnostician Experience

Years of Experience	N	%
2-5	3	7.1
6-10	13	31.0
11-15	13	31.0
16-20	3	7.1
21+	10	23.8

Fewer participants (31%), who had been practicing between 11-15 years, began serving districts around the time of the reauthorization of IDEA 1997 (Public Law 105-17), and participants (30.9%), who had been practicing for 16 or more years, began serving districts under the Education for All Handicapped Children Act of 1975 (Public

Law 94-142). Therefore, most of the participants (61.9%) had been serving as an educational diagnostician during major changes of three or more public law enactments.

Frequencies and percentages were collected for the fourth statement pertaining to the participants' educational diagnostician certification program preparation received (see Table 10). Most of the educational diagnosticians received university based education certification programs compared to a significant fewer participants who received alternative based or other certification programs.

Table 10

Frequency and Percent of Population for Education Certification Program Preparation

Certification Program	N	%
University Based	38	90.5
Alternative Based	2	4.8
Other	2	4.8

Frequencies and percentages were collected for the fifth statement pertaining to the participants' instructional mode of delivery for the educational diagnostician certification program (see Table 11). Most of the educational diagnosticians received total face-to-face instruction (97.6%) compared to the participant who received a mixture of face-to-face and online/web-based instruction (2.4%).

Table 11

Frequency and Percent of Population for Mode of Delivery

Model of Delivery	N	%
Total Face-to-Face	41	97.6
Total Online/Web-Based	0	0.0
Mixture of Face-to-Face and Online/Web-Based	1	2.4

Three demographic questions on the survey instrument referred to the use and training of CHC Theory based assessment. Frequencies and percentages were collected for a first question pertaining to the use and training of CHC Theory based assessment. Information representing participants' district's requirements for initial evaluations is reported in Table 12. Results revealed that most participants used CHC theory based pattern of strengths and weaknesses. Fewer participants used Cross Battery or a combination of CHC theory based pattern of strengths and weaknesses and Cross Battery retrospectively compared to other district requirements for initial evaluations.

Table 12

Frequency and Percent of Population for District Requirements for Initial Evaluations

District Requirement	N	%
CHC Theory Based Pattern of Strengths and Weaknesses	23	54.8
Cross Battery	8	19.0
16 Point Discrepancy	1	2.4
Other Total	10	23.8
Other-Both CHC and Cross Battery	6	14.3
Other-CHC Only Narrow Bands	1	2.4
Other-Glen Hales Cognitive Processing Model	2	4.8
Other-Not Applicable	1	2.4

Frequencies and percentages were collected for the second question pertaining to the use and training of CHC Theory based assessment. Information representing the participants' university based educational diagnostician certification program training in linking CHC theory of cognitive ability to academic learning is reported in Table 13. Most of the participants received no university based certification program training (73.8%). Of the few educational diagnosticians who did receive university training, only a very few participants (9.6%) received one course with one to several sessions and 16.7% received two or more courses with one to several sessions each. Although most of the participants did not receive university training in linking CHC Theory of cognitive ability to academic learning, most diagnosticians received professional development training.

Table 13

Frequency and Percent of Population for University Based Educational Diagnostician Certification Program Training in Linking CHC Theory of Cognitive Ability to Academic Learning

University Based Certification Program Training	N	%
No course or sessions of a course	31	73.8
One course with one session	2	4.8
One course with several sessions	2	4.8
Two or more courses with one session	2	4.8
Two or more courses with several sessions each	5	11.9

Frequencies and percentages were collected for a third question pertaining to the use and training of CHC Theory based assessment. Information representing the participants' professional development focusing on linking CHC theory of cognitive ability to academic learning received during the last two school years is reported in Table 14. Most educational diagnosticians (97.2%) received professional development in regards to linking CHC theory of cognitive ability to academic learning within the last two school years. Half of the participants received more than three days (more than 18 hours) of professional development training compared to fewer participants who received two to three days (7 to 18 hours) and one to six hours. Very few participants received only one day or less (1 to 6 hours).

Table 14

Frequency and Percent of Population for Professional Development in Linking CHC Theory of Cognitive Ability to Academic Learning

Professional Development Training	N	%
None	2	4.8
Between 1 and 3 Hours	3	7.1
One Day (4 to 6 Hours)	2	4.8
Two to Three Days (7 to 18 Hours)	14	33.3
More than Three Days (More than 18 Hours)	21	50.0

Preliminary Data Analysis

Responses from the survey were analyzed using descriptive statistics and cross tabulation X^2 test. Mean scores, standard deviations, and percentages were utilized for responses to research questions 1 through 3. Descriptive analysis was used to explore educational diagnostician's (1) knowledge on the Relationship of Academic Learning to the Cognitive Ability Factors, (2) extent of recommending instructional interventions related to the relationship of Academic Learning to the Cognitive Ability Factors, and (3) extent of recommending accommodations related to the relationship of Academic Learning to the Cognitive Ability Factors. The seven cognitive ability factors pertaining to recommendations included: (1) Crystallized Intelligence (*Gc*), (2) Long-Term Retrieval (*Glr*), (3) Short-Term Memory (*Gsm*), (4) Fluid Reasoning (*Gf*), (5) Auditory Processing (*Ga*), (6) Processing Speed (*Gs*), and (7) Visual Processing (*Gv*).

A cross tabulation X^2 test was conducted to examine the extent to which educational diagnostician level of education, year of educational diagnostician certification, years of educational diagnostician experience, educational diagnostician certification program preparation, mode of delivery, and regional Educational Service Center area influenced their knowledge of the relationship between each of the seven cognitive ability factors and academic ability and on recommending instructional interventions and accommodations. The only statistically significant findings related to (1) the extent possessed knowledge of the relationship between each of the seven cognitive ability factors and academic ability, (2) the extent of recommending instructional interventions related to the relationship between academic learning and each of the seven cognitive ability factors, and (3) the extent of recommending accommodations related to the relationship between academic learning and each of the seven cognitive ability factors are reported.

Definitive Analysis

The survey used a Likert scale approach designed to investigate professional educational diagnosticians for thier acquired knowledge of linking the relationship of Cattell-Horn-Carroll (CHC) theory of cognitive ability and academic learning.

Additionally the survey examined the extent possible of recommending instructional interventions and accommodations based on this relationship between cognitive ability and academic learning. After the data was collected, each choice was assigned a number from one to five.

Extent of knowledge. The data in tables 15 and 16 measure acquired knowledge on the relationship of academic learning and each of the seven cognitive ability factors. Scores reflect "1" to indicate "low", "2" to indicate "somewhat low", "3" to indicate "moderate", "4" to indicate "somewhat high", and "5" to indicate "high" levels of knowledge.

Table 15

Educational Diagnosticians' Extent of Knowledge on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

Relationship of Academic Learning to	Range	Mean	SD
Crystallized Intelligence (*Gc*)	2-5	3.71	.83
Long-Term Retrieval (*Glr*)	3-5	3.69	.72
Short-TermMemory (*Gsm*)	2-5	3.60	.77
Fluid Reasoning (*Gf*)	2-5	3.71	.81
Auditory Processing (*Ga*)	2-5	3.62	.79
Processing Speed (*Gs*)	2-5	3.71	.81
Visual Processing (*Gv*)	2-5	3.57	.83
Total		3.66	.79

Note. Range 1=Low, 2=Somewhat Low, 3=Moderate, 4-Somewhat High, 5=High

Tables 15 and 16 reported the extent of knowledge on the relationship of academic learning to each of the seven cognitive ability factors. These tables respond to research question one: To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to the cognitive ability factors? Forty-two participants answered the questions. As shown in Table 15, range, mean and standard deviation scores were calculated on a scale of "low" to "high" to explore the extent to which educational diagnosticians possessed knowledge on the relationship between academic learning and each of the seven cognitive ability factors. Results revealed that participants reported high levels of acquired knowledge on each of these relationships with very little variance among responses.

Table 16

Percent of Educational Diagnosticians Who Report Knowledge on the Relationship of Academic Learning to the Cognitive Ability Factors (G; N=42)

Relationship of Academic Learning to:	% L 1	% SL 2	% M 3	% SH 4	% H 5
Crystallized Intelligence (*Gc*)	0.0	4.8	38.1	38.1	19.0
Long-Term Retrieval (*Glr*)	0.0	0.0	45.2	40.5	14.3
Short-Term Memory (*Gsm*)	0.0	4.8	42.8	40.5	11.9
Fluid Reasoning (*Gf*)	0.0	2.4	42.9	35.7	19.0
Auditory Processing (*Ga*)	0.0	2.4	49.9	31.0	16.7
Processing Speed (*Gs*)	0.0	2.4	42.9	35.7	19.0
Visual Processing (*Gv*)	0.0	7.1	42.9	35.7	14.3
Total % Average	0.0	3.4	43.6	36.7	16.3

Note: L=Low, SL=Somewhat Low, M=Moderate, SH=Somewhat High, H=High

Percentages were used to report the extent to which educational diagnosticians possessed knowledge on the relationship of academic learning and each of the seven cognitive ability factors, as seen in Table 16. Results revealed that a high percent (92.9%-100%) of participants considered their extent of knowledge on each of these relationships "moderate" to "high." Therefore, very few participants reported the extent of their knowledge as between "low" and "somewhat low". Total percent averages disclose that most participants considered their knowledge as "moderate" to "somewhat high".

Extent of recommending instructional interventions. The data in tables 17 to 32 measure the extent to which professional educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to each of the seven cognitive ability factors. Scores reflect "1" to indicate "never", "2" to indicate "rarely", "3" to indicate "sometimes", "4" to indicate "often", and "5" to indicate "always."

Tables 17 through 32 reported the extent of recommending instructional interventions related to the relationship of academic learning to each of the seven cognitive ability factors. These tables respond to research question two: To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to the cognitive ability factors? Forty-two participants answered the questions.

Crystallized intelligence (Gc). Tables 17 and 18 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship between academic learning and crystallized intelligence (*Gc*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 17. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The intervention: *develop word consciousness, the awareness of, and interest in, words and their meanings* had the most variability.

Table 17

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Crystallized Intelligence (Gc; N=42)

Instructional Interventions	Range	Mean	SD
Create a language and experience rich environment	1-5	4.17	.93
Relate new information to acquired knowledge	3-5	4.29	.64
Assess prior knowledge before introducing new topics or concepts	3-5	4.36	.62
Provide frequent exposure and practice to words	2-5	4.12	.89
Pre-teach relevant vocabulary/background information	2-5	4.45	.63
Develop word consciousness, the awareness of and interest in words and their meanings	1-5	3.57	1.15
Provide explicit vocabulary instruction such as the meaning of common prefixes, suffixes, root words	1-5	3.97	.92
Incorporate interests and prior knowledge experiences into instructional activities.	1-5	4.12	.86
Provide clear and concise language when presenting concepts	2-5	4.33	.75
Check for understanding to ensure comprehension	3-5	4.50	.71
Total Average		4.19	.81

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 18

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Crystallized Intelligence (Gc; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Create a language and experience rich environment	2.4	0.0	21.4	31.0	45.2
Relate new information to acquired knowledge	0.0	0.0	9.5	52.4	38.1
Assess prior knowledge before introducing new topics or concepts	0.0	0.0	7.1	50.0	42.9
Provide frequent exposure and practice to words	0.0	7.1	11.9	42.9	38.1
Pre-teach relevant vocabulary/background information	0.0	2.4	0.0	47.6	50.0
Develop word consciousness, the awareness of and interest in words and their meanings	4.8	14.3	23.8	33.3	23.8
Provide explicit vocabulary instruction such as the meaning of common prefixes, suffixes, root words	2.4	4.8	14.2	50.0	28.6
Incorporate interests and prior knowledge experiences into instructional activities.	2.4	2.4	9.5	52.4	33.3
Provide clear and concise language when presenting concepts	0.0	2.4	9.5	40.5	47.6
Check for understanding to ensure comprehension	0.0	0.0	11.9	26.2	61.9
Total % Average	1.2	3.3	11.9	42.6	41.0

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and crystallized intelligence (*Gc*), as seen in Table 18. Results revealed that a high percentage (80.9%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Long-term retrieval (Glr). Tables 19 and 20 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship between academic learning and long-term retrieval (*Glr*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 19. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The interventions: *check to ensure that the student has retained sufficient information for independent work* and *emphasize concept mastery understood instead of rote memory for rote information in grading rubrics* retrospectively had the most variability.

Table 19

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Long-Term Retrieval (Glr; N=42)

Instructional Interventions	Range	Mean	SD
Teach memory aids such as verbal mediation or rehearsal and mnemonic strategies	2-5	4.24	.82
Provide over-learning through review and repetition	2-5	4.17	.76
Provide a list of steps that will help organize learning behavior and facilitate recall	2-5	3.98	.84
Provide multi-sensory learning using visual, kinesthetic, vocal, and auditory channels as appropriate for the student	2-5	4.12	.83
Emphasize concept mastery understood instead of rote memory for rote information in grading rubrics	1-5	3.62	1.10
Check to ensure that the student has retained sufficient information for independent work	1-5	3.71	1.11
Provide immediate feedback	3-5	4.12	.77
Total Average		3.99	.89

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 20

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Long-Term Retrieval (Glr; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Teach memory aids such as verbal mediation or rehearsal and mnemonic strategies.	0.0	2.4	16.7	35.7	45.2
Provide over-learning through review and repetition.	0.0	2.4	14.3	47.6	35.7
Provide a list of steps that will help organize learning behavior and facilitate recall	0.0	4.8	21.4	45.2	28.6
Provide multi-sensory learning using visual, kinesthetic, vocal, and auditory channels as appropriate for the student	0.0	4.8	14.3	45.2	35.7
Emphasize concept mastery understood instead of rote memory for rote information in grading rubrics	4.8	11.9	21.4	40.5	21.4
Check to ensure that the student has retained sufficient information for independent work	7.1	4.8	21.4	42.9	23.8q
Provide immediate feedback	0.0	0.0	23.8	40.5	35.7
Total % Average	1.7	4.4	19.1	42.5	32.3

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and long-term retrieval (*Glr*), as seen in Table 20. Results revealed that a high percentage (83.3%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Short-term memory (Gsm). Tables 21 and 22 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to short-term memory (*Gsm*). The range, mean and standard deviation scores were calculated on a scale of "never" to "always" in Table 21. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The interventions: *check for understanding of concepts through practice and talk-alouds* and *teach strategies to increase understanding and retention of concepts such as self talk, and creating lists of procedures or steps* retrospectively had the most variability.

Table 21

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Short-Term Memory (Gsm; N=42)

Instructional Interventions	Range	Mean	SD
Teach strategies to increase understanding and retention of concepts such as self talk and creating lists of procedures or steps.	1-5	3.93	1.00
Teach memory strategies such as chunking, verbal rehearsal, and visual imagery.	2-5	4.33	.75
Gain the student's attention before stating a direction	2-5	4.24	.82
Encourage the student to ask for directions or information to be repeated if not understood or remembered	2-5	4.09	.82
Keep oral directions short and simple	3-5	4.45	.55
Have the student repeat or paraphrase directions	3-5	4.12	.74
Provide visual aids such as written directions for assignments.	3-5	4.21	.68
Provide over-learning through review and repetition	2-5	3.93	.84
Check understanding of concepts through practice and talk-alouds	1-5	3.69	1.09
Provide immediate feedback	2-5	4.12	.86
Total Average		4.11	.82

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 22

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Short-Term Memory (Gsm; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Teach strategies to increase understanding and retention of concepts such as self talk, and creating lists of procedures or steps.	2.4	4.8	23.8	35.7	33.3
Teach memory strategies such as chunking, verbal rehearsal, and visual imagery.	0.0	2.4	9.5	40.5	47.6
Gain the student's attention before stating a direction	0.0	2.4	16.7	35.7	45.2
Encourage the student to ask for directions or information to be repeated if not understood or remembered	0.0	4.8	14.3	47.6	33.3
Keep oral directions short and simple	0.0	0.0	2.4	50.0	47.6
Have the student repeat or paraphrase directions	0.0	0.0	21.5	45.2	33.3
Provide visual aids such as written directions for assignments.	0.0	0.0	14.3	50.0	35.7
Provide over-learning through review and repetition	0.0	2.4	30.9	38.1	28.6
Check understanding of concepts through practice and talk-alouds	4.8	7.1	28.6	33.3	26.2
Provide immediate feedback	0.0	2.4	23.8	33.3	40.5
Total % Average	0.7	2.6	18.7	40.9	37.1

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and short-term memory (*Gsm*), as seen in Table 22. Results revealed that a high percentage (88.1% -100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Fluid reasoning (Gf). Tables 23 and 24 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to fluid reasoning (*Gf*). The range, mean, and standard deviation scores are calculated on a scale of "never" to "always" in Table 23. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The interventions: *use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques* and *use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, analyze perspectives* had the most variability.

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and fluid reasoning (*Gf*), as seen in Table 24. Results revealed that a high percentage (85.8%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Table 23

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Fluid Reasoning (Gf; N=42)

Instructional Interventions	Range	Mean	SD
Teach problem-solving techniques in the contexts in which they are most likely to be applied	1-5	4.17	.96
Provide over-learning through repetition and multiple review of concepts	2-5	3.81	.94
Use concrete objects and manipulatives to develop conceptual understanding	2-5	4.33	.79
Use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques	1-5	3.60	1.13
Use think-alouds, guided practice, and feedback.	1-5	3.71	1.07
Use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, analyze perspectives	1-5	3.50	1.13
Monitor for understanding	3-5	4.24	.69
Total Average		3.91	.96

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 24

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Fluid Reasoning (Gf; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Teach problem-solving techniques in the contexts in which they are most likely to be applied	2.4	2.4	16.7	33.3	45.2
Provide over-learning through repetition and multiple review of concepts	0.0	7.1	33.3	31.0	28.6
Use concrete objects and manipulatives to develop conceptual understanding	0.0	2.4	11.9	35.7	50.0
Use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques	2.4	14.3	33.3	21.4	28.6
Use think-alouds, guided practice, and feedback.	4.8	7.1	23.8	40.5	23.8
Use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, analyze perspectives	7.1	7.1	35.8	28.6	21.4
Monitor for understanding	0.0	0.0	14.3	47.6	38.1
Total % Average	2.4	5.8	24.1	34.0	33.7

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

***Auditory processing* (*Ga*).** Tables 25 and 26 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to auditory processing (*Ga*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 25. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The intervention: *provide explicit instructions in sound discrimination, blending, and segmentation* had the most variability.

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and auditory processing (*Ga*), as seen in Table 26. Results revealed that a high percentage (95.2%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always."

Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Table 25

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Auditory Processing (Ga; N=42)

Instructional Interventions	Range	Mean	SD
Provide direct explicit, systematic instruction	3-5	4.38	.66
Provide phonological awareness activities such as rhyming, alliteration, imitation, songs.	2-5	4.00	.80
Provide explicit instructions in sound discrimination, blending, and segmentation	2-5	3.90	.91
Emphasize sound-symbol associations when teaching decoding and spelling	2-5	4.00	.86
Provide visual aids, such as notes or study guides for listening activities	3-5	4.21	.72
Provide assistance with note taking	2-5	3.81	.77
Accompany oral information with visual materials	1-5	4.29	.81
Check for comprehension after directions are given	3-5	4.40	.59
Total Average		4.12	.77

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 26

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Auditory Processing (Ga; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Provide direct explicit, systematic instruction	0.0	0.0	9.5	42.9	47.6
Provide phonological awareness activities such as rhyming, alliteration, imitation, songs.	0.0	2.4	23.8	45.2	28.6
Provide explicit instructions in sound discrimination, blending, and segmentation	0.0	4.8	31.0	33.3	31.0
Emphasize sound-symbol associations when teaching decoding and spelling	0.0	2.4	28.6	35.7	33.3
Provide visual aids, such as notes or study guides for listening activities	0.0	0.0	16.7	45.2	38.1
Provide assistance with note taking	0.0	2.4	33.3	45.2	19.0
Accompany oral information with visual materials	2.4	0.0	7.1	47.6	42.9
Check for comprehension after directions are given	0.0	0.0	4.8	50.0	45.2
Total % Average	0.3	1.5	19.4	43.1	35.7

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Processing speed (Gs). Tables 27 and 28 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning and processing speed (*Gs*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 27. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The interventions: *provide oral discussions* and *encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency* retrospectively had the most variability.

Table 27

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Processing Speed (Gs; N=42)

Instructional Interventions	Range	Mean	SD
Provide oral discussions	1-5	3.12	1.06
Provide activities to increase rate and fluency, such as flash cards or speed drills through educational software	2-5	3.98	.84
Provide strategies that improve the rate of task completion	1-5	3.83	1.03
Encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency	1-5	3.71	1.04
Total Average		3.66	.99

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 28

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Processing Speed (Gs; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Provide oral discussions	7.1	19.00	38.2	26.2	9.5
Provide activities to increase rate and fluency, such as flash cards or speed drills through educational software	0.0	2.4	28.5	38.1	31.0
Provide strategies that improve the rate of task completion	2.4	7.1	26.2	33.3	31.0
Encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency	2.4	9.5	28.6	33.3	26.2
Total Average %	3.0	9.5	30.4	32.7	24.4

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and processing speed (*Gs*), as seen in Table 28. Results revealed that a high percentage (73.9%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "often".

Visual Processing (Gv). Tables 29 and 30 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to visual processing (*Gv*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 29. Results revealed that participants reported recommending these instructional interventions related to this relationship with very little variance. The intervention: *provide copying, tracing, and drawing activities* and *use color coding to illustrate steps* retrospectively had the most variability.

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and visual processing (*Gv*), as seen in Table 30. Results revealed that a high percentage (73.9%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "often".

Table 29

Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Visual Processing (Gv; N=42)

Instructional Interventions	Range	Mean	SD
Provide multisensory learning using visual, kinesthetic, vocal, and auditory channels	1-5	4.05	.96
Use manipulatives during instruction	2-5	4.07	.78
Use language to describe visual forms of information as they are manipulated	2-5	3.60	.86
Provide copying, tracing, and drawing activities	1-5	3.24	1.12
Provide verbal description of graphics and visually-based concepts	1-5	3.43	.97
Use color coding to illustrate steps	1-5	3.21	1.07
Total Average		3.60	.96

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 30

Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Visual Processing (Gv; N=42)

Instructional Interventions	% N 1	% R 2	% S 3	% O 4	% A 5
Provide multisensory learning using visual, kinesthetic, vocal, and auditory channels	2.4	2.4	21.4	35.7	38.1
Use manipulatives during instruction	0.0	4.8	11.8	54.8	28.6
Use language to describe visual forms of information as they are manipulated	0.0	9.5	35.7	40.5	14.3
Provide copying, tracing, and drawing activities	4.8	21.4	35.7	21.4	16.7
Provide verbal description of graphics and visually-based concepts	2.4	16.7	26.2	45.2	9.5
Use color coding to illustrate steps	7.1	19.0	26.3	40.5	7.1
Total % Average	2.8	12.3	26.1	39.7	19.1

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Averages for extent of recommending instructional interventions. Tables 31 and 32 reported the extent to which educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to each of the cognitive ability factors (*G*). Total range, mean, and standard deviation averages were calculated on a scale of "never" to "always" in Table 31. Results revealed that participants reported recommending these instructional interventions related to these relationships with very little variance. Fluid reasoning (*Gf*) and processing speed (*Gs*) had the most variability.

Table 31

Total Extent to which Educational Diagnosticians Recommend Instructional Interventions Based on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

Instructional Interventions Related to the Relationship of Academic Learning to:	Mean	SD
Crystallized Intelligence (*Gc*)	4.19	.81
Long-Term Retrieval (*Glr*)	3.99	.89
Short-Term Memory (*Gsm*)	4.11	.82
Fluid Reasoning (*Gf*)	3.91	.96
Auditory Processing (*Ga*)	4.12	.77
Processing Speed (*Gs*)	3.66	.99
Visual Processing (*Gv*)	3.60	.96
Total Average	3.94	.89

Table 32

Total Percent of Educational Diagnosticians Who Report Recommending Instructional Interventions Based on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

Instructional Interventions Related to the Relationship of Academic Learning to:	% N 1	% R 2	% S 3	% O 4	% A 5
Crystallized Intelligence (*Gc*)	1.2	3.3	11.9	42.6	41.0
Long-Term Retrieval (*Glr*)	1.7	4.4	19.1	42.5	32.3
Short-Term Memory (*Gsm*)	0.7	2.6	18.7	40.9	37.1
Fluid Reasoning (*Gf*)	2.4	5.8	24.1	34.0	33.7
Auditory Processing (*Ga*)	0.3	1.5	19.4	43.1	35.7
Processing Speed (*Gs*)	3.0	9.5	30.4	32.7	24.4
Visual Processing (*Gv*)	2.8	12.3	26.1	39.7	19.1
Total % Average	1.7	5.6	21.4	39.4	31.9

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship between academic learning and each of the cognitive ability factors (*G*), as seen in Table 32. Results revealed that a high percentage (84.9%-100.00%) of participants reported recommending these instructional interventions related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Extent of recommending accommodations. The data in tables 33 to 48 measure the extent to which professional educational diagnosticians recommend possible accommodations related to the relationship between academic learning and each of the seven cognitive ability factors. Scores reflect "1" to indicate "never", "2" to indicate "rarely", "3" to indicate "sometimes", "4" to indicate "often", and "5" to indicate "always." Tables 33 through 48 reported the extent of recommending accommodations related to the relationship between academic learning and each of the seven cognitive ability factors. These tables respond to research question three: To what extent do educational diagnosticians recommend possible accommodations related to the relationship of academic learning to the cognitive ability factors? Forty-two participants answered the questions.

Crystallized intelligence (Gc). Tables 33 and 34 reported the extent to which educational diagnosticians recommended possible accommodations related to the relationship of academic learning to crystallized intelligence (*Gc*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 33. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *provide resources to help students participate in class discussion* had the most variability.

Table 33

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Crystallized Intelligence (Gc; N=42)

Accommodations	Range	Mean	SD
Provide resources to help students participate in class discussion	1-5	3.36	1.06
Provide prompts to enhance written expression	1-5	3.36	.91
Provide preferential seating to enhance monitoring of comprehension	1-5	3.52	1.02
Total Average		3.41	1.00

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and crystallized intelligence (*Gc*), as seen in Table 34. Results revealed that a high percentage (73.8%-83.3%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "sometimes" and "often".

Table 34

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Crystallized Intelligence (Gc; N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Provide resources to help students participate in class discussion	2.4	23.8	21.4	40.5	11.9
Provide prompts to enhance written expression	2.4	14.3	35.7	40.5	7.1
Provide preferential seating to enhance monitoring of comprehension	2.4	14.3	28.5	38.1	16.7
Total % Average	2.4	17.5	28.5	39.7	11.9

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Long-term retrieval (Glr). Tables 35 and 36 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to long-term retrieval (*Glr*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 35. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *limit the amount of information to be learned during an instructional session* had the most variability.

Table 35

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Long-Term Retrieval (Glr; N=42)

Accommodations	Range	Mean	SD
Limit the amount of information to be learned during an instructional session	1-5	3.81	.89
Provide reference sheets, a calculator during math computation	2-5	3.83	.85
Use graphic organizers to reinforce associations between concepts	2-5	4.14	.68
Total Average		3.90	.81

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and long-term retrieval (*Glr*), as seen in Table 36. Results revealed that a high percentage (95.2%-97.6%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "often" and "always".

Table 36

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Long-Term Retrieval (Glr; N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Limit the amount of information to be learned during an instructional session.	2.4	2.4	28.6	45.2	21.4
Provide reference sheets, a calculator during math computation.	0.0	4.8	30.9	40.5	23.8
Use graphic organizers to reinforce associations between concepts	0.0	2.4	9.5	59.5	28.6
Total % Average	0.8	3.2	23.0	48.4	24.6

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Short-term memory (Gsm). Tables 37 and 38 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to short-term memory (*Gsm*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 37. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *provide a study guide to be completed during pauses in presentation* had the most variability.

Table 37

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Short-Term Memory (Gsm) (N=42)

Accommodations	Range	Mean	SD
Provide visual guides during oral presentations	2-5	4.14	.75
Provide lecture notes or arrange for peer-shared notes	2-5	3.93	.71
Provide a study guide to be completed during pauses in presentation	1-5	3.55	1.06
Seat the student in a location away from distractions in order to optimize attention	3-5	4.02	.72
Provide extra time to copy information	2-5	3.76	.88
Read written directions aloud	2-5	3.69	.84
Use graphic organizers to reinforce associations between concepts	2-5	4.00	.77
Total Average		3.87	.82

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 38

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Short-Term Memory (Gsm; N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Provide visual guides during oral presentations	0.0	2.4	14.3	50.0	33.3
Provide lecture notes or arrange for peer-shared notes	0.0	2.4	21.5	57.1	19.0
Provide study guide to be completed during pauses in presentation	4.8	14.3	16.6	50.0	14.3
Seat the student in a location away from distractions in order to optimize attention	0.0	0.0	23.8	50.0	26.2
Provide extra time to copy information	0.0	7.1	31.0	40.5	21.4
Read written directions aloud	0.0	9.5	26.2	50.0	14.3
Use graphic organizers to reinforce associations between concepts	0.0	2.4	21.4	50.0	26.2
Total % Average	0.7	5.4	22.1	49.7	22.1

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and short-term memory (*Gsm*), as seen in Table 38. Results revealed that a high percentage (80.9%-100.00%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "sometimes" and "always".

Fluid reasoning (Gf). Tables 39 and 40 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to fluid reasoning (*Gf*). The mean and standard deviation scores are reported in Table 39. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance in mean and standard deviation scores among most responses. The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 39. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodations: *provide assistance in a timely manner* and provide assistance with functions throughout a task such as when there are changes in task demands retrospectively had the most variability.

Table 39

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Fluid Reasoning (Gf; N=42)

Accommodations	Range	Mean	SD
Provide assistance in a timely manner	1-5	3.71	1.09
Provide assistance with functions throughout a task such as when there are changes in task demands	1-5	3.38	1.03
Use graphic organizers to analyze relationships, such as cause and effect, compare and contrast, classification schemes, and sequential order	3-5	4.02	.78
Seat the student next to a peer helper who can provide assistance	2-5	3.31	.87
Total Average		3.61	.94

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and fluid reasoning (*Gf*), as seen in Table 40. Results revealed that a high percentage (83.3%-100.00%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "sometimes" and "often".

Table 40

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Fluid Reasoning (Gf; N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Provide assistance in a timely manner	4.8	9.5	19.0	42.9	23.8
Provide assistance with functions throughout a task such as when there are changes in task demands	4.8	11.9	38.0	31.0	14.3
Use graphic organizers to analyze relationships, such as cause and effect, compare and contrast, classification schemes, and sequential order	0.0	0.0	28.5	40.5	31.0
Seat the student next to a peer helper who can provide assistance	0.0	16.7	45.2	28.6	9.5
Total % Average	2.4	9.6	32.6	35.7	19.7

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Auditory processing (Ga). Tables 41 and 42 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to auditory processing (*Ga*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 41. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise* had the most variability.

Table 41

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Auditory Processing (Ga; N=42)

Accommodations	Range	Mean	SD
Provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise	1-5	3.81	1.13
Provide a peer assistant or buddy to assist with information when the student does not understand an oral communication	2-5	3.48	.89
Provide preferential seating that supports monitoring of student comprehension	2-5	4.07	.81
Total Average		3.79	.94

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 42

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Auditory Processing (Ga; N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise	2.4	11.9	23.8	26.2	35.7
Provide a peer assistant or buddy to assist with information when the student does not understand an oral communication	0.0	16.7	28.6	45.2	9.5
Provide preferential seating that supports monitoring of student comprehension	0.0	4.8	14.2	50.0	31.0
Total % Average	0.8	11.1	22.2	40.5	25.4

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and auditory processing (*Ga*), as seen in Table 42. Results revealed that a high percentage (83.3%-100.00%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always."

Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "often" and "always."

Processing speed (Gs). Tables 43 and 44 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to processing speed (*Gs*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 43. Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *limit or structure copying activities* had the most variability.

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and processing speed (*Gs*), as seen in Table 44. Results revealed that a high percentage (92.9%-100.00%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "often" and "always".

Table 43

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Processing Speed (Gs; N=42)

Accommodations	Range	Mean	SD
Shorten directions	2-5	4.07	.81
Provide lecture outlines such as a formatted script of notes in which only key words need to be added	1-5	3.81	.89
Limit or structure copying activities	2-5	3.79	.90
Consider individualizing test taking, such as small group	2-5	3.76	.79
Provide extra time to read the text	3-5	4.21	.72
Provide extra time for processing	2-5	4.31	.75
Provide extra time to complete assignments	3-5	4.31	.75
Total Average		4.09	.80

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Table 44

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Processing Speed (Gs) (N=42)

Accommodations	% N 1	% R 2	% S 3	% O 4	% A 5
Shorten directions	0.0	2.4	21.4	42.9	33.3
Provide lecture outlines such as a formatted script of notes in which only key words need to be added	2.4	0.0	35.7	38.1	23.8
Limit or structure copying activities	0.0	7.1	31.0	38.1	23.8
Consider individualizing test taking, such as small group	0.0	2.4	38.1	40.5	19.0
Provide extra time to read the text	0.0	0.0	16.7	45.2	38.1
Provide extra time for processing	0.0	2.4	9.5	42.9	45.2
Provide extra time to complete assignments	0.0	0.0	16.7	35.7	47.6
Total % Average	0.3	2.0	24.2	40.5	33.0

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Visual processing (Gv). Tables 45 and 46 reported the extent to which educational diagnosticians recommend possible accommodations related to the relationship of academic learning to visual processing (*Gv*). The range, mean, and standard deviation scores were calculated on a scale of "never" to "always" in Table 45.

Results revealed that participants reported recommending these accommodations related to this relationship with very little variance. The accommodation: *provide spatial and sequential guides* had the most variability.

Table 45

Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Visual Processing (Gv) (N=42)

Accommodations	Range	Mean	SD
Provide spatial and sequential guides	1-5	3.36	1.03
Provide visual markers to indicate starting location and organization	2-5	3.62	.91
Provide graphic organizers to organize information	2-5	3.95	.85
Total Average		3.64	.93

Note: Range 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and visual processing (*Gv*), as seen in Table 46. Results revealed that a high percentage (78.6%-97.6%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "sometimes" and "often".

Table 46

Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Visual Processing (Gv; N=42)

Accommodation	% N 1	% R 2	% S 3	% O 4	% A 5
Provide spatial and sequential guides	2.4	19.0	33.3	31.0	14.3
Provide visual markers to indicate starting location and organization	0.0	11.9	30.9	40.5	16.7
Provide graphic organizers to organize information	0.0	2.4	30.9	35.7	31.0
Total % Average	0.8	11.1	31.7	35.7	20.7

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Average extent of recommending accommodations. Tables 47 and 48 reported the total extent to which educational diagnosticians recommend possible accommodations related to the relationship between academic learning and each of the cognitive ability factors (*G*). The mean and standard deviation scores were calculated on a scale of "never" to always in Table 47. Results revealed that participants reported recommending these accommodations related to these relationships with very little variance. Accommodations related to the relationship between academic learning and crystallized intelligence (*Gc*) had the most variability.

Table 47

Total Extent to which Educational Diagnosticians Recommend Accommodations Based on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

Accommodations Related to the Relationship of Academic Learning to:	Mean	SD
Crystallized Intelligence (*Gc*)	3.41	1.00
Long-Term Retrieval (*Glr*)	3.90	.81
Short-Term Memory (*Gsm*)	3.87	.82
Fluid Reasoning (*Gf*)	3.61	.94
Auditory Processing (*Ga*)	3.79	.94
Processing Speed (*Gs*)	4.09	.80
Visual Processing (*Gv*)	3.64	.93
Total Average	3.76	.89

Table 48

Total Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Cognitive Ability Factors (G) (N=42)

Accommodations Related to the Relationship of Academic Learning to:	% N 1	% R 2	% S 3	% O 4	% A 5
Crystallized Intelligence (*Gc*)	2.4	23.8	21.4	40.5	11.9
Long-Term Retrieval (*Glr*)	0.8	3.2	23.0	48.4	24.6
Short-Term Memory (*Gsm*)	0.7	5.4	22.1	49.7	22.1
Fluid Reasoning (*Gf*)	2.4	9.6	32.6	35.7	19.7
Auditory Processing (*Ga*)	0.8	11.1	22.2	40.5	25.4
Processing Speed (*Gs*)	0.3	2.0	24.2	40.5	33.0
Visual Processing (*Gv*)	0.8	11.1	31.7	35.7	20.7
Total % Average	1.2	9.5	25.2	41.6	22.5

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Percentages were used to report the extent to which educational diagnosticians recommended possible accommodations related to the relationship between academic learning and each of the cognitive ability factors (*G*), as seen in Table 48. Results revealed that a high percentage (73.8%-100.00%) of participants reported recommending these accommodations related to this relationship as between "sometimes" and "always." Therefore, very few participants reported recommending these accommodations related to this relationship as between "never" and "rarely." Overall total percentage averages disclose that most participants reported recommending these accommodations related to this relationship as between "sometimes" and "often".

Extent diagnosticians recommend. Tables 49 and 50 reported the overall total extent to which educational diagnosticians recommend possible interventions and accommodations related to the relationship between academic learning and each of the cognitive ability factors (*G*). When comparing research questions two and three, mean, standard deviation, and percent overall total scores represent the overall extent of recommending possible instructional interventions and accommodations related to the relationship between academic learning and cognitive ability factors. Table 49 revealed a comparison of the overall total mean and standard deviation averages of instructional interventions and accommodations. Overall results indicated very little variability between scores.

Percentages were used to report the extent to which educational diagnosticians recommend possible instructional interventions and accommodations related to the relationship between academic learning and each of the cognitive ability factors (*G*), as seen in Table 50. Total percentage averages disclosed that, while most participants reported recommending instructional interventions related to this relationship as between often and always, most participants reported recommending accommodations related to this relationship as between "sometimes" and "often." Therefore, overall averages revealed that most professional educational diagnosticians recommended instructional interventions based on this relationship more often than accommodations.

Table 49

Overall Total Extent to which Educational Diagnosticians Recommend Instructional Interventions and Accommodations Based on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

	Mean Average	SD Average
Instructional Interventions Overall Total	3.94	.89
Accommodations Overall Total	3.76	.89

Table 50

Overall Percent of Educational Diagnosticians Who Report Recommending Accommodations Based on the Relationship between Academic Learning and Cognitive Ability Factors (G; N=42)

	% N 1	% R 2	% S 3	% O 4	% A 5
Instructional Interventions Overall Total	1.7	5.6	21.4	39.4	31.9
Accommodations Overall Total	1.2	9.5	25.2	41.6	22.5

Note: N=Never, R=Rarely, S=Sometimes, O=Often, A=Always

Data Analysis

A cross tabulation X^2 test was conducted to examine the educational diagnosticians' period of educational diagnostician certification and educational diagnostician certification program preparation in relation to: the extent of knowledge on the relationship between academic learning and each of the seven cognitive ability factors and on recommending instructional interventions and accommodations based on this relationship. Only the statistically significant findings related to: (1) the extent to which educational diagnosticians possessed knowledge on the relationship of academic learning to cognitive ability factors, (2) the extent to which educational diagnosticians recommended possible instructional interventions related to the relationship of academic learning to cognitive ability factors, and (3) the extent to which educational diagnosticians recommended possible accommodations related to the relationship of academic learning to cognitive ability factors. Data collected was based on the number of participants who completed the demographic information and survey questions.

Level of knowledge. A cross tabulation X^2 test was conducted to compare scores of the participants' level of knowledge and demographic data. When examining the data, only some significant statistical differences occurred when comparing the participants' period of educational diagnostician certification and educational certification program preparation to the extent to which educational diagnosticians possessed knowledge on the relationship of academic learning and each of the seven cognitive ability factors. Percentages are reported in Tables 51 through 55.

Comparison of period of certification and knowledge regarding the relationship between academic learning and long-term retrieval (Glr). A significant relationship was found between the period of educational diagnostician certification and level of knowledge based on the relationship between academic learning and long-term retrieval (*Glr*), X^2 (12)=23.466, p<.05. Percentages for this information are calculated on a scale of "low" to "high" in Table 51.

Table 51

Comparison of Period of Certification and Knowledge Regarding the Relationship between Academic Learning and Long-Term Retrieval (Glr)

Period of Certification	N	% Low 1	% Somewhat Low 2	% Moderate 3	% Somewhat High 4	% High 5
2005-2008	2	0.0	0.0	0.0	0.0	100.0
2000-2004	9	0.0	0.0	66.7	33.3	0.0
1995-1999	10	0.0	0.0	30.0	50.0	20.0
1990-1994	9	0.0	0.0	44.4	55.6	0.0
1985-1989	2	0.0	0.0	100.0	0.0	0.0
1980-1984	5	0.0	0.0	20.0	40.0	40.0
Prior to 1980	5	0.0	0.0	60.0	40.0	0.0
Total	42	0.0	0.0	45.8	31.3	22.9

Most educational diagnosticians who received educational diagnostician certification between 1980 and 2004 considered their level of knowledge based on the relationship between academic learning and long-term retrieval (*Glr*) to have been between "moderate" and "somewhat high" as opposed to "high" by educational diagnosticians who received their certification between 2005 and 2008.

Comparison of certification program preparation and level of knowledge regarding the relationship between academic learning and short-term memory (Gsm). A significant relationship was found between the educational certification program preparation and level of knowledge based on the relationship between academic learning and short-term memory (*Gsm*), X^2 (6)=13.581, p<.05. Percentages for this information are reported in Table 52.

Table 52

Comparison of Certification Program Preparation and Level of Knowledge Regarding the Relationship between Academic Learning and Short-Term Memory (Gsm)

Certification Program Preparation	N	% Low 1	% Somewhat Low 2	% Moderate 3	% Somewhat High 4	% High 5
University Based	38	0.0	2.6	44.8	42.1	10.5
Alternative Based	2	0.0	50.0	0.0	50.0	0.0
Other	2	0.0	0.0	50.0	0.0	50.0
Total	42	0.0	17.5	31.6	30.7	20.2

Most educational diagnosticians who received a university based educational certification program considered their level of knowledge based on the relationship between academic learning and short-term memory (*Gsm*) to have been between "moderate" and "somewhat high" compared to between "somewhat low" to "somewhat high" for educational diagnosticians who received alternative based programs.

Comparison of period of certification and knowledge regarding the relationship between academic learning and fluid reasoning (Gf). A significant relationship was found between the period of educational diagnostician certification and level of knowledge based on the relationship between academic learning and fluid reasoning (*Gf*), $X^2(6)=13.581, p<.05$. Percentages for this information are reported in Table 53.

Table 53

Comparison of Period of Certification and Knowledge Regarding the Relationship between Academic Learning and Fluid Reasoning (Gf)

Period of Certification	N	% Low 1	% Somewhat Low 2	% Moderate 3	% Somewhat High 4	% High 5
2005-2008	2	0.0	0.0	0.0	50.0	50.0
2000-2004	9	0.0	0.0	66.7	22.2	11.1
1995-1999	10	0.0	0.0	30.0	40.0	30.0
1990-1994	9	0.0	0.0	33.3	55.6	11.1
1985-1989	2	0.0	50.0	50.0	0.0	0.0
1980-1984	5	0.0	0.0	40.0	20.0	40.0
Prior to 1980	5	0.0	0.0	60.0	40.0	0.0
Total	42	0.0	7.1	40.1	32.5	20.3

Most educational diagnosticians who received educational diagnostician certification between prior to 1980 and 2004 considered their level of knowledge based on the relationship between academic learning and fluid reasoning (*Gf*) to have been between "moderate" and "somewhat high" as opposed to "somewhat high" to "high" by educational diagnosticians who received their certification between 2005-2008.

Comparison of period of certification and knowledge regarding the relationship between academic learning and auditory processing (Ga). A significant relationship was found between the period of educational diagnostician certification and level of knowledge based on the relationship between academic learning and auditory processing (*Ga*), $X^2(18)=32.164$, $p<.05$. Percentages for this information are reported in Table 54.

Table 54

Comparison of Period of Certification and Knowledge Regarding the Relationship between Academic Learning and Auditory Processing (Ga)

Period of Certification	*N*	*% Low 1*	*% Somewhat Low 2*	*% Moderate 3*	*% Somewhat High 4*	*% High 5*
2005-2008	2	0.0	0.0	50.0	0.0	50.0
2000-2004	9	0.0	0.0	66.7	22.2	11.1
1995-1999	10	0.0	0.0	30.0	40.0	30.0
1990-1994	9	0.0	0.0	66.7	33.3	0.0
1985-1989	2	0.0	50.0	50.0	0.0	0.0
1980-1984	5	0.0	0.0	40.0	20.0	40.0
Prior to 1980	5	0.0	0.0	40.0	60.0	0.0
Total	42	0.0	7.1	49.1	25.1	18.7

Most educational diagnosticians who received educational diagnostician certification between 1990 and 2004 considered their level of knowledge based on the relationship between academic learning and auditory processing (*Ga*) to have been between “moderate” and “somewhat high” as opposed to between “moderate” and “high” for educational diagnosticians who received their certification between 2005 and 2008.

Comparison of period of certification and knowledge regarding the relationship between academic learning and processing speed (Gs). A significant relationship was found between the period of educational diagnostician certification and level of knowledge based on the relationship between academic learning and processing speed (*Gs*), X^2 (18)=32.747, p<.05. Percentages are reported in Table 55.

Table 55

Comparison of Period of Certification and Knowledge Regarding the Relationship between Academic Learning and Processing Speed (Gs)

Period of Certification	N	% Low 1	% Somewhat Low 2	% Moderate 3	% Somewhat High 4	% High 5
2005-2008	2	0.0	0.0	0.0	50.0	50.0
2000-2004	9	0.0	0.0	66.7	11.1	22.2
1995-1999	10	0.0	0.0	30.0	40.0	30.0
1990-1994	9	0.0	0.0	44.4	55.6	0.0
1985-1989	2	0.0	50.0	50.0	0.0	0.0
1980-1984	5	0.0	0.0	20.0	40.0	40.0
Prior to 1980	5	0.0	0.0	60.0	40.0	0.0
Total	42	0.0	7.1	38.8	33.8	20.3

Most educational diagnosticians who received educational diagnostician certification between prior to 1980 and 2004 considered their level of knowledge based on the relationship between academic learning and processing speed (*Gs*) to have been between "moderate" and "somewhat high" as opposed to "somewhat high" to "high" for educational diagnosticians who received their certification between 2005 and 2008.

Extent of recommending instructional interventions. A significant relationship was found between the participants' period of educational diagnostician certification and extent of recommending instructional interventions based on the relationship of academic learning and each of the seven cognitive ability factors. Percentages are reported in Tables 56 through 61.

Comparison of period of certification and extent of recommending an instructional intervention based on the relationship between academic learning and crystallized intelligence (Gc). A significant relationship was found between the period of educational diagnostician certification and the extent of recommending the instructional intervention: *pre-teach relevant vocabulary/background information* based on the relationship between academic learning and crystallized intelligence (*Gc*), X^2 $(18)=34.339$, $p<.05$. Percentages for this information are reported in Table 56. Most educational diagnosticians who received educational diagnostician certification between prior to 1980 and 2004 tended to recommend the instructional intervention "often" to "always" compared to "always" for educational diagnosticians who received their educational diagnostician certification between 2005 and 2008.

Table 56

Comparison of Period of Certification and Extent of Recommending an Instructional Intervention Based on the Relationship between Academic Learning and Crystallized Intelligence (Gc)

Period of Certification	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
2005-2008	2	0.0	0.0	0.0	0.0	100.0
2000-2004	9	0.0	0.0	0.0	55.6	44.4
1995-1999	11	0.0	0.0	0.0	36.4	63.6
1990-1994	10	0.0	0.0	0.0	50.0	50.0
1985-1989	2	0.0	50.0	0.0	0.0	50.0
1980-1984	6	0.0	0.0	16.6	66.7	16.7
Prior to 1980	6	0.0	0.0	0.0	50.0	50.0
Total	46	0.0	7.1	2.4	37.0	53.5

Note: Intervention-Pre-teach relevant vocabulary/background information

Comparison of certification program preparation and extent of recommending an instructional intervention based on the relationship between academic learning and long-term retrieval (Glr). A significant relationship was found between the education certification program preparation and the extent of recommending an instructional intervention, provide a list of steps that will help organize learning behavior and facilitate recall, based on the relationship between academic learning and long-term retrieval (*Glr*),

X^2 (6)=13.127, p<.05. Percentages for this information are reported in Table 57. Most educational diagnosticians who received a university based education certification program recommended the instructional intervention "often" to "always" compared to "often" by educational diagnosticians who received their certification from an alternative based program.

Table 57

Comparison of Certification Program Preparation and Extent of Recommending an Instructional Intervention Based on the Relationship between Academic Learning and Long-Term Retrieval (Glr)

Certification Program Preparation	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
University Based	38	0.0	2.6	23.8	44.7	28.9
Alternative Based	2	0.0	0.0	0.0	100.0	0.0
Other	2	0.0	50.0	0.0	0.0	50.0
Total	42	0.0	17.5	8.0	48.2	26.3

Note: Intervention-Provide a list of steps that will help organize learning behavior and facilitate recall

Comparison of certification program preparation and extent of recommending an instructional intervention based on the relationship between academic learning and visual processing (Gv). A significant relationship was found between the education certification program preparation and the extent of recommending the instructional intervention: *provide multisensory learning using visual kinesthetic, vocal, and auditory channels as appropriate for the student* based on the relationship between academic learning and visual processing (*Gv*), $X^2(6)=12.759$, $p<.05$. Percentages are reported in Table 58. Most educational diagnosticians who received a university based education certification program recommended the instructional intervention "often" to "always" compared to "often" by educational diagnosticians who received their certification from an alternative based program.

Table 58

Comparison of Certification Program Preparation and Extent of Recommending an Instructional Intervention Based on the Relationship between Academic Learning and Visual Processing (Gv)

Certification Program Preparation	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
University Based	38	0.0	2.6	15.9	44.7	36.8
Alternative Based	2	0.0	0.0	0.0	100.0	0.0
Other	2	0.0	50.0	0.0	0.0	50.0
Total	42	0.0	17.5	5.4	48.2	28.9

Note: Intervention-Provide multisensory learning using visual kinesthetic, vocal, and auditory channels as appropriate for the student

Comparison of certification program preparation and extent of recommending an instructional intervention based on the relationship between academic learning and fluid reasoning (Gf). A significant relationship was found between the education certification program preparation and the extent of recommending the instructional intervention: *teach problem-solving techniques in the contexts in which they are most likely to be applied* based on the relationship between academic learning and fluid reasoning (*Gf*), X^2 (8)=21.706, p<.05. Percentages for this information are reported in Table 59. Most educational diagnosticians who received a university and alternative based education certification program recommend the instructional intervention "often" to "always" compared to a few who recommend the intervention "never" and "sometimes".

Table 59

Comparison of Certification Program Preparation and Extent of Recommending an Instructional Intervention Based on the Relationship between Academic Learning and Fluid Reasoning (Gf)

Certification Program Preparation	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
University Based	38	2.6	0.0	18.5	34.2	44.7
Alternative Based	2	0.0	0.0	0.0	50.0	50.0
Other	2	0.0	50.0	0.0	0.0	50.0
Total	42	.09	16.7	6.1	28.1	48.2

Note: Intervention-Teach problem-solving techniques in the contexts in which they are most likely to be applied.

Comparison of certification program preparation and extent of recommending an instructional intervention based on the relationship between academic learning and auditory processing (Ga). A significant relationship was found between the education certification program preparation and the extent of recommending the instructional intervention: *emphasize sound-symbol associations when teaching decoding and spelling* based on the relationship between academic learning and auditory processing (*Ga*) and the education certification program preparation, $X^2\,(6)=25.895$, $p<.05$. Percentages for this information are reported in Table 60. Most educational diagnosticians who received a university based education certification program recommended the instructional intervention "sometimes" to "always," compared to "always" by educational diagnosticians who received their certification from an alternative based program.

Table 60

Comparison of Certification Program Preparation and Extent of Recommending an Instructional Intervention Based on the Relationship between Academic Learning and Auditory Processing (Ga)

Certification Program Preparation	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
University Based	38	0.0	0.0	31.6	39.5	28.9
Alternative Based	2	0.0	0.0	0.0	0.0	100.0
Other	2	0.0	50.0	0.0	0.0	50.0
Total	42	0.0	16.7	10.5	13.2	59.6

Note: Intervention-Emphasize sound-symbol associations when teaching decoding and spelling

Extent of recommending accommodations. A significant relationship was found between the participants' period of educational diagnostician certification and educational certification program preparation and the extent of recommending accommodations based on the relationship of academic learning and each of the seven cognitive ability factors. Percentages are reported in Tables 61 through 63.

Comparison of certification program preparation and extent of recommending an accommodation based on the relationship between academic learning and short-term memory (Gsm). A significant relationship was found between the education certification program preparation and the extent of recommending the accommodation: *provide visual guides during oral presentations* based on the relationship between academic learning and short-term memory (*Gsm*), X^2 (6)=23.474, p<.05. Percentages are reported in Table 61. Most educational diagnosticians who received a university based education certification program recommended the instructional intervention "sometimes" to "always," compared to "always" by educational diagnosticians who received their certification from an alternative based program.

Comparison of period of certification and extent of recommending an accommodation based on the relationship between academic learning and short-term memory (Gsm). A significant relationship was found between the period of educational diagnostician certification and extent of recommending the accommodation: *provide extra time to copy information* based on the relationship of academic learning to Short-Term Memory (*Gsm*), X^2 (18)=31.291, p<.05. Percentages for this information are reported in Table 62. Results revealed that educational diagnosticians who received educational diagnostician certification between prior to 1980 and 2004 significantly tend to recommend this specific accommodation "sometimes" to "often" compared to "always" by educational diagnosticians who received their educational diagnostician certification between 2005-2008.

Table 61

Comparison of Certification Program Preparation and Extent of Recommending an Accommodation Based on the Relationship between Academic Learning and Short-Term Memory (Gsm)

Certification Program Preparation	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
University Based	38	0.0	0.0	15.8	50.0	34.2
Alternative Based	2	0.0	0.0	0.0	100.0	0.0
Other	2	0.0	50.0	0.0	0.0	50.0
Total	42	0.0	16.7	5.2	50.0	28.1

Note: Accommodation-Provide visual guides during oral presentations

Table 62

Comparison of Period of Certification and Extent of Recommending an Accommodation Based on the Relationship between Academic Learning and Short-Term Memory (Gsm)

Period of Certification	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
2005-2008	2	0.0	0.0	0.0	0.0	100.0
2000-2004	9	0.0	0.0	66.7	22.2	11.1
1995-1999	10	0.0	0.0	40.0	40.0	20.0
1990-1994	9	0.0	22.2	33.4	22.2	22.2
1985-1989	2	0.0	0.0	0.0	100.0	0.0
1980-1984	5	0.0	20.0	0.0	40.0	40.0
Prior to 1980	5	0.0	0.0	0.0	100.0	0.0
Total	42	0.0	6.0	20.1	46.3	27.6

Note: Accommodation-Provide extra time to copy information

Comparison of period of certification and extent of recommending an accommodation based on the relationship between academic learning and fluid reasoning (Gf). A significant relationship was found between the period of educational diagnostician certification and the extent of recommending the accommodation: *seat the student next to a peer helper who can provide assistance* based on the relationship of academic learning to fluid reasoning (*Gf*), X^2 (18)=31.130, $p<.05$. Percentages are reported in Table 63. Most educational diagnosticians who received their certification between prior to 1980 and 2004 tend to recommend the accommodation between "sometimes" and "often" compared to "always" by educational diagnosticians who received their certification between 2005 and 2008.

Table 63

Comparison of Period of Certification and Extent of Recommending an Accommodation Based on the Relationship between Academic Learning and Fluid Reasoning (Gf)

Period of Certification	N	% Never 1	% Rarely 2	% Sometimes 3	% Often 4	% Always 5
2005-2008	2	0.0	0.0	0.0	0.0	100.0
2000-2004	9	0.0	33.3	55.6	11.1	0.0
1995-1999	10	0.0	20.0	60.0	20.0	0.0
1990-1994	9	0.0	11.1	33.4	44.4	11.1
1985-1989	2	0.0	0.0	50.0	50.0	0.0
1980-1984	5	0.0	20.0	60.0	20.0	0.0
Prior to 1980	5	0.0	0.0	20.0	60.0	20.0
Total	42	0.0	12.1	39.8	29.4	18.7

Note: Accommodation-Seat the student next to a peer helper who can provide assistance

Cronbach's Alpha

Cronbach's Alpha was conducted to measure inter-reliability as noted in Table 64. Results present no statistically significant data concerning the inter-reliability between the level of knowledge, instructional interventions and accommodations based on the relationship between academic learning and each cognitive ability factor. Cronbach's Alpha reliability inter-reliability results are reported in relation to each of seven cognitive ability factors.

Table 64

Inter-reliability between Level of Knowledge, Instructional Interventions and Accommodations Based on the Relationship between Academic Learning and Cognitive Ability Factors (G)

Cognitive Ability Factor (*G*)	K	Cronbach's Alpha
Crystallized Intelligence (*Gc*) with Academic Learning	14	.90
Long-Term Retrieval (*Glr*) with Academic Learning	11	.78
Short-Term Memory (*Gsm*) with Academic Learning	18	.90
Fluid Reasoning (*Gf*) with Academic Learning	12	.87
Auditory Processing (*Ga*) with Academic Learning	12	.86
Processing Speed (*Gs*) with Academic Learning	12	.88
Visual Processing (*Gv*) with Academic Learning	10	.87

Note: K=Number of level of knowledge, instructional interventions and accommodations related to cognitive ability factor (*G*).

Summary of Phase One Results

The results of phase one suggested that educational diagnosticians reported having knowledge of the relationship between cognitive ability factors and academic learning. Moreover, they reported that they recommend instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning.

In regards to the educational diagnosticians' education, most participants have a Master's degree plus post-Master's hours, obtained certification between 1990 and 2000 under the Education for all Handicapped Children Act of 1975 and IDEA 1997, have had 6 to 15 or 21+ years of experience, and received a university based certification program with a total face-to-face mode of delivery. Their school districts required CHC theory based pattern of strengths and weaknesses with Cross Battery. Their university experience did not have courses or course sessions that focused on linking CHC theory of cognitive ability to academic learning; however, they had 2 to 3 or more days of 7 to 18+ hours of professional development that focused on linking CHC theory of cognitive ability to academic learning.

Range, mean, standard deviation, and percentage scores were collected to reveal the extent of knowledge on the relationship of academic learning to each of the seven cognitive ability factors. This collected data responded to research question one. To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to the cognitive ability factors? Mean and standard deviation results revealed that participants reported acquired knowledge on each of these relationships with very little variance.

Percentage results revealed that most participants considered their extent of knowledge on each of these relationships as between moderate and high. Very few participants reported the extent of their knowledge on the relationships as between low and somewhat low. Total percentage averages disclosed that most participants considered their knowledge as between moderate and somewhat high.

Range, mean, standard deviation, and percentage scores were collected to reveal the extent of recommending instructional interventions related to the relationship of academic learning to each of the seven cognitive ability factors. This collected data responded to research question two. To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to the cognitive ability factors? Results revealed that participants reported recommending instructional interventions related to these relationships with very little variance.

Percentages were used to report the extent to which educational diagnosticians recommend instructional interventions related to these relationships as between "often" and "always". Very few participants reported recommending these instructional interventions related to this relationship as between "never" and "rarely". Total averages disclosed that most participants reported recommending these instructional interventions related to this relationship as between "often" and "always".

Range, mean, standard deviation, and percentage scores were collected to reveal the extent of recommending accommodations related to the relationship of academic learning to each of the seven cognitive ability factors. These tables respond to research question three. To what extent do educational diagnosticians recommend possible accommodations related to the relationship of academic learning to the cognitive ability factors? Results revealed that participants reported recommending these accommodations related to these relationships with very little variance.

Percentages were used to report the extent to which educational diagnosticians recommend accommodations related to these relationships as between “sometimes” and “always”. Very few participants reported recommending these instructional interventions related to this relationship as between “never” and “rarely”. Total averages disclosed that most participants reported recommending these instructional interventions related to this relationship as between “sometimes” and “often”.

When comparing research questions two and three, mean and standard deviation overall total scores represented the extent of recommending possible instructional interventions and accommodations related to the relationship between academic learning and cognitive ability factors. Overall results indicated that educational diagnosticians tended to recommend instructional interventions related to the relationship of academic learning to each of the seven cognitive ability factors slightly more often than accommodations. Total percentage averages disclosed that while most participants reported recommending instructional interventions related to this relationship as between “often” and “always”, most participants reported recommending accommodations related to this relationship as between "sometimes" and "often". Therefore, overall averages revealed that most professional educational diagnosticians recommend instructional interventions based on this relationship more often than accommodations.

A cross tabulation X^2 test was conducted to compare scores of the participants' level of knowledge and demographic data. When examining the data, only some significant statistical differences occurred when comparing the participants' period of educational diagnostician certification and educational certification program preparation with the extent to which educational diagnosticians possess knowledge on the relationship of academic learning and each of the seven cognitive ability factors.

Statistically significant percentages indicated that most educational diagnosticians who received university based education certification program preparation considered their level of knowledge based on the relationship between academic learning and short-term memory (*Gsm*) to be "moderate" compared educational diagnosticians who received alternative based certification programs. In addition, a statistically significant number of educational diagnosticians who received their educational diagnostician certification between prior to 1980 and 2004 considered their level of knowledge based on the relationship between academic learning and log-term retrieval (*Glr*), fluid reasoning (*Gf*), auditory processing (*Ga*), and processing speed (*Gs*) to have been between "moderate" and "somewhat high".

A cross tabulation X^2 test was conducted to compare scores of the participants' extent of recommending instructional interventions and accommodations based on the relationship of academic learning and each of the seven cognitive ability factors to the participants' period of educational diagnostician certification and educational certification program preparation. Statistically significant percentages noted the comparison of period of educational diagnostician certification and extent of recommending an instructional intervention related to the relationship of academic learning to crystallized intelligence (*Gc*) and visual processing (*Gv*). Results indicated that educational diagnosticians who received certification during 2005 through 2008 recommend specific instructional interventions based on these relationships "always" compared "often" to "always" for educational diagnosticians who received their educational diagnostician certification during prior to 1980 through 2004.

In addition, the comparison of certification program preparation and extent of recommending an instructional intervention based on the relationship between academic learning and long-term retrieval (*Glr*) and visual processing (*Gv*). Results indicated that educational diagnosticians who received a university based education certification program recommended the instructional interventions "often" to "always" compared to "often" by educational diagnosticians who received their certification from an alternative based program.

Statistically significant percentages noted the comparison of period of educational diagnostician certification and extent of recommending an accommodation related to the relationship between academic learning and short-term memory (*Gsm*) and fluid reasoning (*Gf*). Results indicated that educational diagnosticians who received certification during 2005 through 2008 recommend specific accommodations based on these relationships "always" compared "often" to "always" for educational diagnosticians who received their educational diagnostician certification during prior to 1980 through 2004.

In addition, the comparison of certification program preparation and extent of recommending an accommodation based on the relationship between academic learning and short-term memory (*Gsm*). Results indicated that educational diagnosticians who received a university based education certification program recommended the instructional interventions “often” to “always,” compared to “often” by educational diagnosticians who received their certification from an alternative based program.

Cronbach’s Alpha was conducted for measuring inter-reliability between the level of knowledge and the recommendations of instructional interventions and accommodations based on the relationship between academic learning and cognitive ability factor. Results demonstrated no statistically significant data concerning the inter-reliability between the level of knowledge, instructional interventions and accommodations based on the relationship between academic learning and each of seven cognitive ability factors.

Qualitative Phase

Focus Group Purpose

The purpose of the qualitative phase was to clarify how professional educational diagnosticians acquired knowledge of linking the relationship between cognitive ability factors and academic learning and their recommendations of instructional interventions and accommodations. This section reports the findings of the focus group which was conducted in accordance with Metaplan methodology.

Focus Group Participants

The focus group participants were randomly selected from survey participants who completed the survey, volunteered by indicating their choice for participation in the focus group, and provided contact information for a consent form. The focus group consisted of five participants who were professional educational diagnosticians. The demographic data for educational diagnosticians who participated in the focus group are listed in Table 65.

Demographic data was reported in mean and standard deviation scores. The primary assignment for focus group participants was grades pre-k through 5th grade. The average level of education was Master's degree plus post-Master's hours. One participant had only a Master's degree. The average year of certification was between 2000 and 2004 with one participant's certification between 2005 and 2008. The average years of educational diagnostician experience were between 6 and 10. One participant had between 2 and 5 years.

All school districts required CHC theory based pattern of strengths and weaknesses for initial evaluations. The average professional development focusing on CHC theory was more than 3 days (more than 18 hours) with one participant having received two to three days (7 to 18 hours). The average amount of information received during the educational diagnostician preparation program on linking CHC theory of cognitive ability to academic learning was 2.2 including three participants who had no course or sessions of a course, one had one course with several sessions, and one had two or more courses with several sessions each.

Table 65

Focus Group Demographic Data for Educational Diagnostician Participants (N=5)

	Population Average	Mean	SD
Primary Assignment	Elementary	1.00	0.00
Level of Education	Masters plus post Masters hours	1.80	.45
Period Certification	2000-2004	1.80	.45
Years of Diagnostician Experience	6-10	1.80	.45
District Initial Evaluation Requirements	CHC	1.00	0.00
Professional Development Focusing on CHC Theory	More than 3 days (7-18 hrs.)	1.80	.45
Educational Diagnostician Preparation Program on Linking Cognitive Ability to Academic Learning	No Course No Session	1.60	1.79
Education Certification Program Preparation	University	2.40	.55
Certification Program Mode of Delivery	Face-to-Face	1.80	.89
Gender	Female	1.80	.45
Ethnicity	Caucasian	1.80	.45
School District: Rural, Suburban, Urban	Urban	1.00	0.00
Regional Educational Service Center	Region10	1.00	0.00

Note. CHC = Cattell-Horn-Carroll

The average education certification program preparation was university based certification with two who had alternative based certification. The average education certification program preparation mode of delivery was total face-to-face with one who had a mixture of face-to-face and online/web-based. Most participants were female, with only one male. The majority of participants reported their ethnicity as Caucasian, with one having Hispanic heritage. All participants served in an urban school district within the Region 10 Educational Service Center.

Focus Group Data Analysis

The five focus group questions were provided to focus group participants to address research question four in regards to educational diagnosticians' perceptions regarding the quality of their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

Responses from the focus group were analyzed using descriptive statistics. Focus group questions one through five were calculated using mean scores and standard deviations to explore educational diagnosticians' perceptions regarding the quality of their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

From the rating sheets, mean ratings were calculated for each category by tallying the number of values circled by participants for a specific category and dividing the total number by the number of respondents. Next, standard deviations were calculated for each of the individual categories.

Following the focus group meeting, the moderator analyzed the rating and voting sheets. A tally mark systemization process was utilized to determine how the participant ranked the top category choices. Each time a category appeared on a participant's voting sheet a tally mark was noted for that category. The category with the most tally marks received a group rank of one, the next category with the highest number received a two, and so forth. Multiple categories were ranked based on the most important category ratings of category 1 being the highest rating, category 2 being the next highest rating, and so on. The highest category rating received a subgroup ranking of A for the highest category ranking and B for the second highest subgroup ranking, and so forth.

Tables 66-68 reported the mean ratings, standard deviations, group votes, and group ranks for each category. Description and interpretation of the qualitative research question and related focus group questions are provided.

Research question four. What are educational diagnosticians' perceptions regarding the quality of their training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory?

Learning experiences for knowledge and skills.

Focus group question 1A.

Prompt for focus group question 1A:

> Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction.

Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

Focus group question 1A:

Think back on the variety of ways you acquired knowledge and skills on the relationship between cognitive ability factors and academic learning reflected in the CHC theory. How did you acquire the knowledge and skills for linking cognitive ability factors with academic learning?

Mean rate based on individual ratings, standard deviation, group votes based on raw votes of the group and group rate based on individual ratings are reported in Table 66. Participants ranked literature review, collaboration, and professional development, as the most important learning experiences that educator preparation programs provide in the acquisition of knowledge and skills for linking cognitive ability factors with academic learning. Professional development ranked the highest mean rate. Technology and school based learning experiences retrospectively ranked the least important categories for this question.

Table 66

Categories of Acquired Learning Experience for Linking Cognitive Ability with Academic Learning

Categories	MR	SD	GV	GR
Lit Review	2.00	1.15	4	1
School Base	1.00	0.00	1	3
Technology	2.00	1.41	2	2
Collaboration	2.00	0.00	4	1
Professional Development	2.25	.96	4	1

Note: MR=Mean Rate (based on individual ratings); SD=Standard Deviation; GV=Group Votes (based on raw votes of the group); GR=Group Rank (based on member votes)

Focus group question 1B.

Prompt for focus group questions 1B:

You just described the specific learning experiences that help you link the relationship between cognitive ability factors and academic learning.

Focus group question 1B:

What would have better prepared you to link the relationship between cognitive ability factors and academic learning?

Mean rate based on individual ratings, standard deviation, group votes based on raw votes of the group and group rate based on individual ratings were collected for this information are reported in Table 67.

Table 67

Categories of Desired Learning Experiences for Linking Cognitive Ability with Academic Learning

Categories	MR	SD	GV	GR
Formal University Training	2.00	1.15	4	2
Advance Professional Development	2.00	0.00	5	1
Formal Teacher Training	2.00	1.41	2	4
Case Studies	1.00	0.00	1	5
Collaboration	1.33	.96	3	3

Note: MR=Mean Rate (based on individual ratings); SD=Standard Deviation; GV=Group Votes (based on raw votes of the group); GR=Group Rank (based on member votes)

Participants ranked advanced professional development, formal university training and collaboration retrospectively as the most important learning experiences that educator preparation programs need to provide. Formal teacher training and case studies received the lowest number of group votes as needed learning experiences respectively. Formal training including formal university training, advanced professional development and formal teacher training equally had the highest mean rates.

Possible instructional interventions and accommodations.

Focus group question 2A.

Prompt for focus group question 2A:

> Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction.

Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3).

Focus group question 2A:

Think back on the variety of ways you acquired knowledge and skills of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible instructional interventions do you currently recommend based on CHC theory?

Mean rate based on individual ratings, standard deviation, group votes based on raw votes of the group and group rate based on individual ratings were collected for this information and are reported in Table 68. Results revealed that categories received consistent ranking in terms of group vote and rank. Participants ranked memory/retrieval, vocabulary and visual aids retrospectively as the most important recommended instructional interventions based on linking cognitive ability factors to academic learning. Customized and manipulatives recommended instructional interventions had the lowest number of group votes respectively. Decoding and vocabulary had the highest standard deviation scores retrospectively.

Table 68

Categories of Recommended Instructional Interventions Based on Linking Cognitive Ability Factors with Academic Learning

Categories	MR	SD	GV	GR
Decoding	2.50	1.15	2	4
Manipulatives	0.00	0.00	0	6
Customized	3.00	0.00	1	5
Vocabulary	2.25	1.41	4	2
Visual Aids	2.00	0.00	3	3
Memory/Retrieval	1.40	.96	5	1

Note: MR=Mean Rate (based on individual ratings); SD-Standard Deviation; GV=Group Votes (based on raw votes of the group); GR=Group Rank (based on member votes)

Focus group question 2B.

Prompt for focus group question 2B:

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. These accommodations provide support that helps the student access instruction and curriculum for academic learning. Accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71).

Focus group question 2B:

Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible accommodations do you currently recommend based on CHC theory?

Mean rate based on individual ratings, standard deviation, group votes based on raw votes of the group and group rate based on individual ratings were collected for this information are reported in Table 69. Participants ranked visual and writing alternatives as the most important recommended accommodations based on linking cognitive ability factors with academic learning. Environmental and testing accommodations had the lowest number of group votes respectively. Visual and environmental accommodations had the highest standard deviation respectively.

Table 69

Categories of Recommended Accommodations Based on Linking Cognitive Ability Factors with Academic Learning

Categories	MR	SD	GV	GR
Visual	2.50	1.15	4	1
Writing Alternatives	1.67	0.00	4	1
Testing	0.00	0.00	0	4
Environmental	1.00	1.41	2	3
Time	2.33	0.00	3	2
Oral	2.00	.96	3	2

Note: MR=Mean Rate (based on individual ratings); SD=Standard Deviation; GV=Group Votes (based on raw votes of the group); GR=Group Rank (based on member votes)

Barriers encountered.

Focus group question 3.

Prompt for focus group question 3:

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

Focus group question 3:

Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What barriers do you encounter when linking CHC theory to academic learning?

Mean rate based on individual ratings, standard deviation, group votes based on raw votes of the group and group rate based on individual ratings were collected for this information are reported in Table 70. The categories for barriers encountered by educational diagnosticians to link CHC theory to academic learning were consistent in terms of group vote and rank. Participants ranked application, communication and cultural/language as the most important barriers respectively when linking CHC theory of cognitive ability to academic learning. The barriers of time and school issues had the lowest number of group votes respectively. School issues and application received the highest standard deviation scores.

Table 70

Categories of Barriers Related to Linking CHC Theory to Academic Learning

Categories	MR	SD	GV	GR
Application	2.80	1.15	5	1
Cultural/Language	2.00	0.00	3	3
School Issues	2.00	1.41	1	5
Time	1.00	0.00	2	4
Communication	1.50	.96	4	2

Note: MR=Mean Rate (based on individual ratings); SD=Standard Deviation; GV=Group Votes (based on raw votes of the group); GR=Group Rank (based on member votes)

Summary of Phase Two Results

Educational diagnosticians reported having knowledge of the relationship between CHC theory of cognitive ability factors and academic learning. They also reported that they recommend instructional interventions and accommodations based on this knowledge. The results of phase two suggested that educational diagnosticians received quality professional development training and study group learning experiences related to the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) Theory. Demographic data collected revealed that most educational diagnosticians had no formal training during their educational diagnostician certification preparation programs on this relationship; however, most of them reported having more than three days of professional development training. Participants reported the most important learning experiences related to this relationship include literature review, collaboration and professional development equally as the most important learning experiences that provide the acquisition of knowledge and skills for linking cognitive ability factors with academic learning. In addition, they reported the need for better preparation in linking the relationship between cognitive ability factors and academic learning. Specifically, they ranked advanced professional development, formal university training, and collaboration respectively as the most important categories for better preparation learning experiences.

Participants also reported recommending possible instructional interventions and accommodations based on the relationship between CHC cognitive ability and academic learning. They specifically ranked the most important recommended instructional interventions as memory/retrieval, vocabulary, and visual aids respectively. They also reported visual and writing alternatives respectively as the most important recommended accommodations based this relationship.

In addition, participants specified specific barriers encountered when linking CHC theory to academic learning. They ranked application, communication and cultural/language respectively as the most important barriers to linking CHC theory of cognitive ability to academic learning.

Limitations

This study design used a quasi-experimental mixed model methodology, which was organized into two phases. The first phase of this study was a descriptive quantitative design utilizing survey methodology. The second phase of the study was a qualitative design utilizing focus group methodology. A description of the study phases of limitations follows.

Quantitative Phase Limitations

This study was conducted using a descriptive design by which participants reported on their personal behaviors pertaining to knowledge on the relationship of academic learning to cognitive ability factors and recommending instructional interventions and accommodations based on this relationship. Reliance on self-reporting may have resulted in inflation of perceived positive behaviors. In contrast, participants may have under-reported perceived negative behaviors. In addition, participants who completed the survey consisted of participants who had some interest in responding (Gay, Mills, & Airasian). Also, the requirement of participants to pass a registry exam in order to obtain membership in the professional educational diagnosticians' organization implies that members are highly qualified educational diagnosticians. Consequently, the results may potentially be skewed to highly qualified participants who responded and not representative of all educational diagnosticians in the state of Texas.

Qualitative Phase Limitations.

The small number of participants (N=5) limited the results of the study findings. Focus groups were generally composed of 7 to 10 participants, but may ranged to as small as 4 or as large as 12. Due to the nature of a focus group format, participants may not have openly discussed their viewpoints, limiting the findings of the study.

Overall, the limitation of this research study was the generalizability to a larger population. Therefore, future research studies should be based on a larger population of participants.

Delimitations

Chosen population was the first delimitation of the study. The sample consisted of professional educational diagnosticians. Only those participants who responded to the survey and who participated in the focus group were included in this study. The second delimitation was the generalizability of the study due to descriptive design of the quantitative study and the possibility that the highly qualified membership requirements of educational diagnosticians were representative of current population of educational diagnosticians. The strongest results of any quantitative method were provided by only true experimental research because of the clear evidence provided for determining a cause and effect relationship (Gay, Mills, & Airasian).

CHAPTER V

DISCUSSION

The inclusion of students with disabilities in state and district assessments to measure educational programs raises expectations and concerns for decisions regarding instruction and accommodations for improving all student performance, including students identified with SLD receiving special education services (Christensen, Thurlow, & Wang, 2009). Understanding the nature of academic learning in relation to the neurological basis of SLD as patterns of strengths and weaknesses implicate the need to develop recommendations focused on the relationship between cognitive ability factors and academic learning needs in order to improve student performance.

The collaboration between the special education teacher and general education teachers implicates the need of communicating recommendations justified by specific cognitive ability and achievement skill weaknesses. State mandates and national agencies for supporting special education professionals provide additional support in the need for effective communication in interpreting assessment and evaluation results to parents/guardians and professionals.

The reauthorization of IDEIA (2004) requires that one of its purposes is "to ensure that educators and parents have the necessary tools to improve educational results for children with disabilities…" (p. 5). The *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) was developed for reasons similar to this purpose of IDEIA (2004). This tool assists in the organization and communication of recommendations by directly linking student performance results of a psycho-educational assessment to improve student performance for children with disabilities. Specifically, this tool links cognitive ability factors with achievement, provides implications of this linkage to academic learning, and offers possible instructional interventions and accommodations to improve cognitive and achievement weaknesses.

Utilization of the *Linking CHC to Intervention Tool* assists in effectively communicating assessment results to a decision making team of knowledgeable individuals consisting of an evaluator, parents, educators, and administrators. Implementation of the *Linking CHC to Intervention Tool* will enrich knowledge of student needs and consequently assist in developing effective interventions and accommodations to improve student performance (Proctor & Stephens, 2010).

In addition to the provision of application and communication based on linking CHC theory to academic learning, the recommendations based on this relationship provide optimal support for the educational learning environment. This enriched learning environment encourages nurture neurological and cognitive growth to strengthen related cognitive ability factors and academic learning for improved student performance.

In order to provide the most effective recommendations for instructional interventions and accommodations, educational diagnosticians must be equipped to link cognitive ability factors with achievement and academic learning based on CHC theory to identify the pattern of strengths and weaknesses that may affect lack of progress in performance and/or achievement. The application of knowledge and skills gained from this line of research prepare diagnosticians to recommend possible instructional interventions and accommodations to classroom teachers and parents when planning of instruction for students with SLD (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009), as well as make recommendations for students who do not meet the criteria or state guidelines as a student with SLD.

The current study examined the extent educational diagnosticians: (1) possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) recommend possible evidence-based instructional interventions based on CHC theory, (3) recommend accommodations based on CHC theory, and (4) educational diagnosticians' perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

The quantitative phase, online survey methodology, was completed by 42 participants representing 8.4% of the professional education diagnosticians' population from 60% of the Regional Education Service Centers across Texas. The responses were analyzed using descriptive statistics and cross tabulation X^2 measures to examine: (1) the educational diagnosticians' educational diagnostician certification program preparation, (2) the period of educational diagnostician certification in relation to the extent of knowledge on the relationship between each of the seven general intelligence factors, and (3) the academic ability on recommending instructional interventions and accommodations based on this relationship. Most educational diagnosticians reported having knowledge of the relationship between CHC theory of cognitive ability factors and academic learning. They also reported that they recommend instructional interventions and accommodations based on this knowledge.

Cronbach's Alpha was conducted to determine inter-reliability between the level of knowledge and the recommendations of instructional interventions and accommodations. Results revealed strong inter-reliability between the level of knowledge, instructional interventions, and accommodations.

The qualitative phase, Metaplan methodology, consisted of a focus group meeting with educational diagnosticians. Individual responses were examined, placed into categories, and ranked by the focus group members according to metaplan methodology. Mean ratings and standard deviations were calculated for each set of responses. The following variables were identified: (1) the most important categories for acquired learning experiences in relation to the relationship between cognitive ability factors and academic learning included professional development, collaboration and literature review; (2) the most important categories for desired learning experience based on this relationship included advanced professional development, formal university training, and collaboration; (3) the most important categories for recommended instructional interventions based on this relationship included memory/retrieval, vocabulary, and visual aids; (4) the most important categories for recommended accommodations based on this relationship included visual and writing alternatives; and (5) the most important barriers related to linking CHC theory to academic learning included application, communication, and cultural/language.

The first finding from this study related to research question one: To what extent do educational diagnosticians possess knowledge on the relationship of academic learning to cognitive ability factors? Results revealed that educational diagnosticians consider their extent of knowledge based on the relationship of academic learning to each of the cognitive ability factors (*G*) to have been within a range of somewhat low (2) to high (5) with a mean average between 3.57 and 3.71. In addition, standard deviation scores reveal that very little variability occurred between scores ranging from .72 to .83.

Percentage scores reveal that 93.5 and 100% of educational diagnosticians considered their possessed knowledge to be "moderate" to "high" regarding the relationship of the seven general intelligence factors (*G*) to academic learning. This knowledge essentially meets federal and state law requirements that criteria for an identification of SLD include the identification of a pattern of strengths and weaknesses in performance, achievement, or both performance and achievement. The identification of cognitive ability and achievement strengths and weaknesses for struggling students with and without SLD drive recommendations for instructional interventions and accommodations that improve individual needs for student performance.

The second finding from this study related to research question two: To what extent do educational diagnosticians recommend possible instructional interventions related to the relationship of academic learning to cognitive ability factors? Mean averages revealed that between 3.60 and 4.19 with standard deviation scores ranging between .77 and .99 represented little variability between scores. Percentage results indicated that between 84.91% and 98.16 % of educational diagnosticians recommended evidenced-based instructional interventions based on the relationship between academic learning and cognitive ability factors. Collaborative efforts of special education teachers and general education teachers on recommending instructional interventions meet NCLB (2004) requirements for student needs. The provision of evidence-based instructional practices based on the relationship between cognitive ability and academic learning empirically establishes an optimal learning environment. Nurturing the development of neurological processes enhances the improvement of student performance for struggling students with and without SLD in inclusion general education classes.

The third finding from this study related to the third research question: To what extent do educational diagnosticians recommend possible accommodations related to the relationship of academic learning to cognitive ability factors? Mean averages revealed that between 3.41 and 4.09 with standard deviation scores ranging between .81 and 1.00 represented little variability between scores. Percentage results suggested that between 78.97 and 97.16 % of educational diagnosticians recommended accommodations based on the relationship between academic learning and cognitive ability factors. The provision of accommodations provides support that helps the student access instruction and curriculum for academic learning. The use of accommodations based on the relationship between specific cognitive ability factor weaknesses and achievement weaknesses in an optimal supported inclusion classroom builds an interactive learning experience with enriched environmental support. Collaborative efforts of special education teachers and general education teachers on recommending accommodations meet NCLB (2004) requirements for student needs. The provision of these accommodations develop stronger neurological systems for improving cognitive ability and academic learning. Access allows opportunity for higher levels of thinking to reflect cognitive development and express academic learning. These developments result in improved student performance for struggling students with and without SLD in inclusion general education classes.

Finally, the fourth finding from this study related to the fourth research question: What are educational diagnosticians' perceptions regarding the quality of training and/or preparation programs related to the relationship between cognitive ability and academic learning as presented in Cattell Horn-Carroll (CHC) theory? Educational diagnosticians who participated in the focus group presented the need for educational learning experiences to include advanced professional development, formal university training, and collaboration to better prepare educational diagnosticians to link the relationship between cognitive ability factors and academic learning. They also reported that application and communication were the pertinent barriers they encountered when linking CHC theory to academic learning. The reauthorization of IDEIA (2004) states as one of its purposes "to ensure that educators and parents have the necessary tools to improve educational results for children with disabilities…" (p. 5). Therefore, knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

The *Linking CHC to Intervention Tool* provides evaluators, such as educational diagnosticians, to be able to apply and communicate the link between cognitive ability factors and academic learning to identify a pattern of strengths and weaknesses. The knowledge gained from the tool's visual representation of student ability will enable effective communication between educational team members including evaluators, parents, teachers, and administrators for the provision of recommended instructional interventions and accommodations that nurture an enriched learning environment for improving student performance.

Implications for Future Research

The current study has provided information regarding the extent educational diagnosticians: (1) possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, (2) recommend possible evidence-based instructional interventions based on CHC theory, (3) recommend accommodations based on CHC theory, and (4) perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

Future studies need to address a generalized population. A larger population of evaluators including first year certified educational diagnosticians and Licensed Specialists in School Psychology (LSSP). Depending on the quality of education preparation programs, educational diagnosticians and LSSPs who have recently completed their certification training may experience difficulty with the identification of a pattern of strengths and weaknesses based on this relationship. In turn, they may experience more difficulty with recommending evidence-based instructional interventions and accommodations related to this relationship. Therefore, future studies need to identify and address specific needs of future evaluators completing education certification programs in Texas.

The second variable that should be considered carefully is ethnicity. In this study, the majority of the population was Caucasian, which is commensurate with state and national populations of professional evaluators. There is a need for a diverse population of evaluators with cultural and linguistic perspectives and knowledge base to address the needs of current practices in evaluation of the cultural and linguistically diverse population of students in Texas. Therefore, future research studies should include a more diverse population of evaluators.

Future studies need to investigate populations of educational diagnosticians who receive nontraditional certification program mode of delivery. This study's population's educational diagnostician certification program mode of delivery was mostly "total face-to-face" with a few "mixture of face-to-face and online/web-based". With an increase in "total online/web-based" educational diagnostician certification program mode of delivery, future research needs to evaluate its effectiveness in preparing educational diagnosticians with knowledge and skills in acquiring CHC theory of cognitive ability, its relationship to academic learning, and recommendations of instructional-interventions and accommodations based on this relationship.

Research studies also need to evaluate the quality of advanced professional development at the university level as well as regional Educational Service Center level on training in knowledge of the relationship between academic learning and cognitive ability factors and recommending instructional interventions and accommodations based on this relationship. Advanced professional development needs to include neurological and cognitive research related to optimal support of recommended instructional interventions and accommodations based on the link between cognitive ability and academic learning. Student performance may implicate improved cognitive ability and academic learning as a consequence of neurological and cognitive development.

Finally, research studies need to evaluate the effectiveness of tools such as the *Linking CHC to Intervention Tool* (Proctor & Stephens, 2010). The provision of tools that help to eliminate barriers in application and communication are essential for increasing awareness of student needs that drive quality recommendations to improve student performance. Therefore, future research studies need to examine the *Linking CHC to Intervention Tool* (Proctor & Stephens) for: (1) measuring the effectiveness of communication of student abilities and recommendations based on the relationship of cognitive ability to academic learning, (2) surveying parents' understanding of student abilities and recommendations based on this relationship, and (3) measuring student performacn in inclusion class rooms that utilize instructional interventiosn and accommodations based on the relationship of cognitive ability and academic learning. Sudents' three year re-evaluations should also be analyzed for improved cognitive abilities and achievement effecting academic learning.

Conclusion

This study was based on federal and state mandates that require an evaluation to include the provision of evidence-based classroom instruction, the lack of progress in the general education classroom, and the indication of a pattern of strengths and weaknesses for the identification of SLD (Commissioner's Rules, 2001; IDEIA, 2004; NCLB, 2004). Research studies implicate that cognitive ability develops as a consequence of neurological/biological development and interaction with the learning environment. The effectiveness of academic learning depends on the interactive, cyclical development of interrelationship between cognitive ability and achievement. MRI research studies indicating neurological correlates of SLD in the areas of reading (Fletcher, Lyon, Fuchs, & Barnes, 2007; Gorman, 2003; Hillis, 2005; Kleinschmidt & Cohen, 2006; Milne, 2005; Poldrack, 2001; Shaywitz, 2003; Tsapkini & Rapp, 2009; Wolf, 2007), writing (Richards, et al., 2009;), and math (Ansari, 2009; Eimeren, Niogi, McCandliss, & Ansari, 2008; Morton, Bosma, & Ansari, 2009; Stanescu-Cosson, Pinel, et al., 2000) implicate the possibility of rewiring existing neural network systems for improved academic performance. Therefore, design of an ability-oriented evaluation helps to establish a pattern of strengths and weaknesses based on the relationship between cognitive ability factors and achievement based on CHC theory (Dehn, 2006, 2008; Gregg & Lindstrom, 2008; Mather & Wendling, 2005; McGrew, 2005; Rathvon, 2008; Wendling & Mather, 2009) to indicate student needs.

The state competency requirements to provide appropriate communication for reporting and interpreting assessment and evaluation results (Texas Administrative Code,

2002) and federally mandated need to ensure that educators and parents have the necessary tools to improve educational results for students with SLD (IDEIA, 2004) indicate evaluator needs. The provision of an ability-oriented evaluation, based on CHC theory that identifies a pattern of strengths and weakness in relation to the relationship between cognitive ability factors and academic learning, implicates specific recommendations and accommodations for enriching the learning environment with optimal support. Focus group results indicated the need for communication and application support in linking cognitive ability to academic learning. The provision of tools such as the *Linking CHC to Intervention Tool* (Proctor and Stephens, 2010) provide evaluators with a process to link the relationship between cognitive ability and achievement to evidence-based instructional interventions and accommodations. These provisions will enrich the general education learning environment to improve student performance of students with SLD as well as general education students at-risk for SLD.

The focus on improving student performance from the perspective of strengths and weaknesses will change instructional focus of instruction from meeting expectations of state assessment to meeting expectations of student needs. Therefore, quality student performance in state assessment should become a byproduct of rich educational environments based on student needs for instructional interventions and accommodations. The reevaluation of students with SLD will indicate effectiveness of instructional interventions and accommodations as well as implicate changes in student needs as effective neurological/cognitive systems develop. These acquired cognitive and learning abilities will not only impact the struggling students at hand, but also will impact future generations of these struggling students with and without SLD as they extend their improved academic learning through the engagement in interactive learning experiences with their parents, grandparents, and future children. Then, the provision of future enriched environmental learning experiences with optimal support will continue to nurture neurological and cognitive growth for continued development of academic learning throughout future generations.

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APPENDIX A

LINKING CHC TO INTERVENTION TOOL

Student: ID# Date of FIE:

Linking *CHC to Intervention Tool

Cognitive Ability Factor	Related Achievement Normative Weaknesses	Relationship to Academic Learning	Recommended Instructional Interventions	Recommended Accommodations
Crystallized Intelligence (*Gc*) is a person's level of acquired knowledge, including domain knowledge obtained through life experiences, school and work. *Gc* Cluster Average: _______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Basic Reading _____ ☐ Reading Comp. _____ ☐ Math Calculations _____ ☐ Math Problem Solving _____ ☐ Written Expression _____ ☐ Oral Expression _____ ☐ Listening Comp. _____ (Check Normative Weakness <85)	•*Gc* has a strong and consistent relationship to reading, writing, and math, such as learning vocabulary, answering factual questions, and comprehending oral/written language, all of which are highly predictive of academic success.	•Create a language and experience rich environment. •Relate new information to acquired knowledge. •Assess prior knowledge before introducing new topics or concepts. •Provide frequent exposure and practice to words. •Pre-teach relevant vocabulary/background information. •Develop word consciousness, the awareness of and interest in words and their meanings. •Provide explicit vocabulary instruction such as the meaning of common prefixes, suffixes, and root words. •Incorporate interests and prior knowledge experiences into instructional activities. •Provide clear and concise language when presenting concepts. •Check for understanding to ensure comprehension. •Other…	•Provide resources to help students participate in class discussion. •Provide prompts to enhance written expression. •Provide preferential seating to enhance monitoring of comprehension. •Other…
Long-Term Retrieval (*Glr*) is the ability to take and store a variety of information (ideas, names, concepts) in one's mind, then later retrieve it quickly and easily using association. *Glr* Cluster Average: _______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Basic Reading _____ (Naming Facility) ☐ Reading Fluency _____ (Naming Facility) ☐ Written Expression _____ (Naming Facility) ☐ Oral Expression _____ (Check Normative Weakness <85)	•*Glr* has a significant relationship with reading and writing especially during early stages of skill acquisition, such as organizing for retrieval, strategies for recall, and learning and retrieving information.	•Teach memory aids such as verbal mediation or rehearsal and mnemonic strategies. •Provide over-learning through review and repetition. •Provide a list of steps that will help organize learning behavior and facilitate recall. •Provide multisensory learning using visual, kinesthetic, vocal, and auditory channels. •Emphasize concept mastery understood instead of rote memory for rote information in grading rubrics. •Check to ensure that the student has retained sufficient information for independent work. •Provide immediate feedback. •Other…	•Limit the amount of information to be learned during an instructional session. •Provide reference sheets, a calculator during math computation. •Use graphic organizers to reinforce associations between concepts. •Other…
Short-Term Memory (*Gsm*) is the ability to apprehend and hold information in one's mind and then use it within a few seconds; includes working memory (ability to attend to, process, and respond to information). *Gsm* Cluster Average: _______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Basic Reading _____ ☐ Reading Comp. _____ ☐ Math Calculations _____ ☐ Written Expression _____ ☐ Oral Expression _____ ☐ Listening Comp. _____ (Check Normative Weakness <85)	•*Gsm* has a significant relationship to reading, writing, and math (working memory in particular), such as attending/following directions, recalling sequences, memorizing actual information, listening and comprehending, and taking notes.	•Teach strategies to increase understanding and retention of concepts such as self talk and creating lists of procedures or steps. •Teach memory strategies such as chunking, verbal rehearsal, and visual imagery. •Gain the student's attention before stating a direction. •Encourage asking for directions or information to be repeated if not understood or remembered. •Keep oral directions short and simple. •Have the student repeat or paraphrase directions. •Provide visual aids such as written directions for assignments. •Provide over-learning through review and repetition. •Check understanding of concepts through practice and talk-alouds. •Provide immediate feedback. •Other…	•Provide visual guides during oral presentations. •Provide lecture notes or arrange for peer-shared notes. •Provide a study guide to be completed during pauses in presentation. •Seat the student in a location away from distractions in order to optimize attention. •Provide extra time to copy information. •Read written directions aloud. •Use graphic organizers to reinforce associations between concepts. •Other…

1 *Cattell-Horn-Carroll Theory

Student: ID# Date of FIE:

Cognitive Ability Factor	Related Achievement Normative Weaknesses	Relationship to Academic Learning	Recommended Instructional Interventions	Recommended Accommodations
Fluid Reasoning (*Gf*) is the type of thinking an individual may use when faced with a relatively new task that cannot be performed automatically; a problem solving type of intelligence. *Gf* Cluster Average: ______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Reading Comp. _____ ☐ Math Calculations _____ ☐ Math Problem Solving _____ ☐ Written Expression _____ (Check Normative Weakness <85)	•*Gf* has a significant relationship to higher level skills in reading, writing, and math, such as problem solving, drawing inferences, mental flexibility, transferring and generalizing, and thinking conceptually.	•Teach problem-solving techniques in the contexts in which they are most likely to be applied. •Provide over-learning through repetition and multiple review of concepts. •Use concrete objects and manipulatives to develop conceptual understanding. •Use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques. •Use think-alouds, guided practice, and feedback. •Use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, analyze perspectives. •Monitor for understanding. •Other…	•Provide assistance in a timely manner •Provide assistance with functions throughout a task such as when there are changes in task demands. •Seat the student next to a peer helper who can provide assistance. •Use graphic organizers to analyze relationships, such as cause and effect, compare and contrast, classification schemes, and sequential order. •Other..
Auditory Processing (*Ga*) is the ability to perceive, analyze, and synthesize patterns among auditory stimuli (sounds) and to discriminate subtle nuances in patterns of sound and speech when presented under distortion conditions. *Ga* Cluster Average: ______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Basic Reading _____ (Phonetic Coding) ☐ Written Expression _____ (Phonetic Coding) ☐ Listening Comp. _____ (Check Normative Weakness <85)	•*Ga* has a significant relationship to reading and writing, especially during early stages of skill acquisition, such as acquiring phonics, sequencing sounds, listening, learning foreign language, and musical skills.	•Provide direct explicit, systematic instruction. •Provide phonological awareness activities such as rhyming, alliteration, imitation, songs. •Provide explicit, instructions in sound discrimination, blending, and segmentation. •Emphasize sound-symbol associations when teaching decoding and spelling. •Provide visual aids, such as notes or study guides for listening activities. •Provide assistance with note taking. •Accompany oral information with visual materials. •Check for comprehension after directions are given. •Other…	•Provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise. •Provide a peer assistant or buddy to assist with information when the student does not understand an oral communication. •Provide preferential seating that supports monitoring of student comprehension. •Other…
Processing Speed (*Gs*) is the ability to fluently and automatically perform cognitive tasks, especially when under pressure to maintain focused attention and concentration. *Gs* Cluster Average: ______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Basic Reading (P) _____ ☐ Reading Comp. (P) _____ ☐ Reading Fluency _____ ☐ Math Calculations (P) _____ ☐ Math Problem Solving (P) _____ ☐ Written Expression (P) _____ (P)=Perceptual Speed (Check Normative Weakness <85)	•*Gs* has a significant relationship to reading, writing, and math especially during early stages of learning, such as completing assignments on time, processing information quickly, taking timed tests, and copying from the board.	•Provide oral discussions. •Provide activities to increase rate and fluency, such as flash cards or speed drills through educational software. •Provide strategies that improve the rate of task completion. •Encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency. •Other…	•Shorten directions. •Provide lecture outlines such as a formatted script of notes in which only key words need to be added. •Limit or structure copying activities •Consider individualizing test taking, such as small group. •Provide extra time to read the text. •Provide extra time for processing. •Provide extra time to complete assignments. •Other…
Visual Processing (*Gv*) is the ability to think about and generate, perceive, analyze, synthesize, store, retrieve, manipulate, transform, and think with visual patterns and stimuli. *Gv* Cluster Average: ______ ☐ Weakness (≤84) ☐ Within Normal Limits (85-115) ☐ Strength (≥116) ☐ Uninterpretable	SS ☐ Reading Fluency _____ (Visual Memory) ☐ Math Calculations _____ (Advanced Math) ☐ Math Problem Solving _____ (Advanced Math) (Check Normative Weakness <85)	•*Gv* has some relationship to reading fluency and higher level math, such as using patterns and designs, sensing spatial orientation and boundaries, and noting visual detail.	•Provide multisensory learning using visual, kinesthetic, vocal, and auditory channels. •Use manipulatives during instruction. •Use language to describe visual forms of information as they are manipulated. •Provide copying, tracing, and drawing activities. •Provide verbal description of graphics and visually-based concepts. •Use color coding to illustrate steps. •Other…	•Provide spatial and sequential guides. •Provide visual markers to indicate starting location and organization. •Provide graphic organizers to organize information. •Other…

 *Cattell-Horn-Carroll Theory

Student: ID# Date of FIE:

SUMMARY:

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APPENDIX B

LINKING CHC TO INTERVENTION TOOL:

PROCEDURES FOR DOCUMENTING AND SUMMARIZING

THE ASSESSMENT RESULTS AND RECOMMENDATIONS

Linking CHC to Intervention Tool: Procedures for
Documenting and Summarizing the Assessment Results and Recommendations

Pages 1 & 2

1. Use a psychometric conversion table to convert all scores to standard scores with a mean of 100.
2. Use the Cross Battery Approach to provide a mathematical average for verifying strengths and weaknesses of interpretable scores, nonunitary and uninterpretable scores. Note: Nonunitary statistically significant subtest scores implicate a *G* factor: weakness if subtest scores are below average; within normal limits if subtest scores are average, **or** strength if subtest scores are above average. If Cross Battery confirms nonunitary statistically significant subtest scores that indicate various abilities among: weaknesses; within normal range; **and/or** strengths, the *G* factor is considered uninterpretable.
3. Use the Culture-Language Interpretive Matrix (C-LIM) to provide a mathematical conversion of standardized scores based on the degree of cultural loading and the degree of linguistic demand for diverse individuals.
4. Under the *Cognitive Ability Factor* column, document the general intelligence factor (*G*) cluster average standard score for each cognitive ability area assessed. **Do not identify the specific scores** of Cross Battery mathematical average, C-LIM mathematical conversion of standardized scores or uninterpretable scores.
5. Check the appropriate box to represent the cognitive ability cluster score as a weakness with a standard score or converted score equal to or below 84, within normal limits with a score between 85 and 115, strength with a score equal to or

above 116, or uninterpretable scores. Indicate Cross Battery mathematical average or C-LIM mathematical conversion of standardized score weaknesses, within normal limits, and strengths may be indicated by checking the appropriate box for each *G* factor without reporting specific scores.

6. Under the *Related Achievement Normative Weaknesses* column, document each achievement skill normative standard score or score with a converted score in parenthesis if applicable, i.e. 7 (85) for each achievement skill assessed.
7. Check the box if the achievement score is a normative weakness with a standard score or converted score less than 85.
8. Analyze the cognitive ability factor strengths as they relate to strengths in achievement skills and cognitive ability weaknesses as they relate to achievement skill weaknesses.

Page 3

9. Write a summary of assessment findings:
    a. explain the relationship between cognitive ability factors and achievement strengths, within normal limits, and weaknesses.
    b. explain how this relationship implicates the quality of student performance.
    c. explain how specific interventions and accommodations may improve cognitive abilities and achievement skills for improved quality student performance.
    d. explain nonunitary, and/or uninterpretable scores with implications for instructional interventions and accommodations. Recommendations may be considered for specific narrow-band normative weaknesses.

e. explain the relationship between cognitive ability factors and achievement ability level based on the degree of cultural loading and the degree of linguistic demand for diverse individuals.

10. Explain these results with elaborative explanations, examples from the assessment and protocol documentation, samples of student work and school records.
11. Explain recommended instructional interventions and accommodations based on the cognitive and achievement strengths and weakness.

The *Linking CHC to Intervention Tool* (Proctor and Albright, 2010) may be duplicated and utilized in educational settings as a tool to represent evaluation results.

APPENDIX C

IRB APPROVAL

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 Fax 940-898-3416
e-mail: IRB@twu.edu

February 4, 2010

Ms. Carla Mackey Proctor

Dear Ms. Proctor:

Re: Educational Diagnosticians' Perceptions on the Link Between CHC Theory and Recommendations of Instructional Interventions and Accommodations

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the annual/final report is enclosed. A final report must be filed with the Institutional Review Board at the completion of the study. Because you do not utilize a signed consent form for your study, the filing of signatures of subjects with the IRB is not required.

This approval is valid one year from February 4, 2010. According to regulations from the Department of Health and Human Services, another review by the IRB is required if your project changes in any way, and the IRB must be notified immediately regarding any adverse events. If you have any questions, feel free to call the TWU Institutional Review Board.

Sincerely,

Kathy DeOrnellas, PhD.

Dr. Kathy DeOrnellas, Chair
Institutional Review Board - Denton

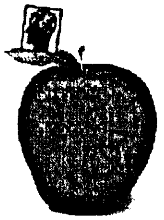
enc.

cc. Dr. Jane Pemberton, Department of Teacher Education
Dr. Joyce Rademacher, Department of Teacher Education
Graduate School

APPENDIX D

SURVEY

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations



I understand that the return of my completed survey questionnaire constitutes my informed consent to act as a participant in this research.

The purpose of this survey is three fold:

1. to determine to what extent educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory and its relationship to academic learning.

2. to determine to what extent educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory.

3. to determine to what extent educational diagnosticians recommend accommodations based on CHC theory.

Upon completion of this survey, participants will have an opportunity to choose to receive a copy of the results of this survey.

Participants may also choose to receive a revised copy of the "Linking CHC to Intervention Tool" (Proctor & Albright, 2010). This tool provides educational diagnosticians with a quick view of a definition of each G factor of cognitive ability according to CHC theory, G factor related achievement normative weaknesses, the relationship of each G factor to academic learning, and recommended evidenced-based instructional interventions and accommodations based on the relationship between cognitive ability and academic learning.

Page Break

Part I

Demographics

Please complete the following information about yourself and your school.

- Current position:
  - Educational Diagnostician whose primary assignment is grades pre-K through 5th.
  - Educational Diagnostician whose primary assignment is grades 6th through 8th
  - Educational Diagnostician whose primary assignment is grades 9th-12th.
  - Other (please indicate in the box below)

Current position: Other (please specify)

- Level of education:
  - Master's Degree
  - Master's Degree plus Post-Master's hours
  - Doctoral Degree
  - Other (please indicate in the box below)

Level of education: Other (please specify)

- Year of educational diagnostician certification
  - 2005-2009
  - 2000-2004
  - 1995-1999

- 1990-1994
- 1985-1989
- 1980-1984
- Prior to 1980

- Years of educational diagnostician experience:
  - 2-5
  - 6-10
  - 11-15
  - 16-20
  - 21+

- What does your district require for initial evaluations?
  - CHC theory based pattern of strengths and weaknesses
  - Cross Battery
  - 16 Point Descrepancy
  - Other: (please specify)

Requirements for initial evaluations: Other (please specify)

(1000 characters remaining)

- What professional development focusing on linking CHC theory of cognitive ability to academic learning did you receive either this school year or last school year?
  - None
  - Between 1 and 3 hours
  - One day (4 to 6 hours)
  - Two to three days (7 to 18 hours)
  - More than 3 days (more than 18 hours)

- Identify the amount of information you received during your educational diagnostician preparation program on linking CHC theory of cognitive ability to academic learning
  - No course or sessions of a course
  - One course with one session
  - One course with several sessions
  - Two or more courses with one session
  - Two or more with several sessions each

- Type of educational certification program.
  - University Based
  - Alternative Based
  - Other (please specify)

Educational certification: Other (please specify)

- Educational diagnostician certification program mode of delivery:
  - Total face-to-face.
  - Total online/web-based.
  - Mixture of face-to-face and online/web-based.

- Gender:
  - Male
  - Female

- Ethnicity:

- Caucasian
- Hispanic
- African American
- Asian/Pacific Islander
- Native American
- Other (please specify)

Ethnicity: Other (please specify)

* How do you describe your school district?
  - Rural
  - Suburban
  - Urban

* What regional Education Service Center serves your district?
  - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20

Page Break

Part II

Linking CHC Cognitive Ability Factors to Academic Learning

G factors of cognitive ability as presented in Cattel-Horn-Carroll (CHC) theory have been linked to academic difficulties experienced by children with learning disabilities. An ability-oriented evaluation consists of assessment that focuses on understanding a student's cognitive ability to process information and includes CHC factors that facilitate academic learning. Learning disability is caused by inherent weaknesses underlying cognitive processes. These cognitive process abilities are interrelated with academic abilities. Therefore, the design of an ability-oriented evaluation helps formulate the problem and determine specific instructional interventions and accommodations (Flanagan & Harrison, 2005, p. 274).

DIRECTIONS

1. Read the definition of the G factor.

2. Complete the bubble rating scale that indicates your perception of the relationship of each G factor to academic learning.

3. Complete the bubble rating scale to indicate the extent to which you **recommend** possible **instructional interventions** related to this G.

4. Complete the bubble rating scale to indicate the extent to which you **recommend** possible **accommodations** related to this G.

Page Break

Part II A. Crystallized Intelligence (Gc)

Crystallized Intelligence (Gc) is a person's level of acquired knowledge, including domain knowledge obtained through life experiences, school and work.

* A. I perceive my level of knowledge regarding the relationship of Crystallized Intelligence (Gc) to academic learning as:
  - Low - Somewhat Low - Moderate - Somewhat High - High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to Crystallized Intelligence (Gc).

	Never	Rarely	Sometimes	Often	Always
Create a language and experience rich environment.	○	○	○	○	○
Relate new information to acquired knowledge.	○	○	○	○	○
Assess prior knowledge before introducing new topics or concepts.	○	○	○	○	○
Provide frequent exposure and practice to words.	○	○	○	○	○
Pre-teach relevant vocabulary/background information.	○	○	○	○	○
Develop word consciousness, the awareness of and interest in words and their meanings.	○	○	○	○	○
Provide explicit vocabulary instruction such as the meaning of common prefixes, suffixes, root words.	○	○	○	○	○

•	Incorporate interests and prior knowledge experiences into instructional activities.				
•	Provide clear and concise language when presenting concepts.				
•	Check for understanding to ensure comprehension.				
•	Other (please indicate in the box below)				

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Crystallized Intelligence (Gc).

		Never	Rarely	Sometimes	Often	Always
•	Provide resources to help students participate in class discussion					
•	Provide prompts to enhance written expression.					
•	Provide preferential seating to enhance monitoring of comprehension					
•	Other (please indicate in the box below)					

Other (please specify)

Page Break

Part II B. Long-Term Retrieval (Glr)

Long-Term Retrieval (Glr) is the ability to take & store a variety of information (ideas, names, concepts)in one's mind, then later retrieve it quickly and easily using association.

- A. I perceive my level of knowledge regarding the relationship of Long-Term Retrieval (Glr) to academic learning as:

  Low   Somewhat Low   Moderate   Somewhat High   High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to this Long-Term Retrieval (Glr).

		Never	Rarely	Sometimes	Often	Always
•	Teach memory aids such as verbal mediation or rehearsal and mnemonic strategies.					
•	Provide over-learning through review and repetition					
•	Provide a list of steps that will help organize learning behavior and facilitate recall.					
•	Provide multi-sensory learning using visual, kinesthetic, vocal, and auditory channels as appropriate for the student.					
•	Emphasize concept mastery understood instead of rote memory for rote information in grading rubrics.					
•	Check to ensure that the student has retained sufficient information for independent work.					
•	Provide immediate feedback.					
•	Other (please indicate in the box below)					

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Long-Term Retrieval (Glr).

		Never	Rarely	Sometimes	Often	Always
•	Limit the amount of information to be learned during an instructional session.					
•	Provide reference sheets, a calculator during math computation.					

	Never	Rarely	Sometimes	Often	Always
• Use graphic organizers to reinforce associations between concepts.					
• Other (please indicate in the box below)					

Other (please specify)

---Page Break---

Part II C. Short-Term Memory (Gsm)

Short-Term Memory (Gsm) is the ability to apprehend and hold information in one's mind and then use it within a few seconds; includes working memory (ability to attend to, process, & respond to information).

- A. I perceive my level of knowledge regarding the relationship of Short-Term Memory (Gsm) to academic learning as:

  Low Somewhat Low Moderate Somewhat High High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to Short-Term Memory (Gsm).

	Never	Rarely	Sometimes	Often	Always
• Teach strategies to increase understanding and retention of concepts such as self talk, and creating lists of procedures or steps.					
• Teach memory strategies such as chunking, verbal rehearsal, and visual imagery.					
• Gain the student's attention before stating a direction.					
• Encourage the student to ask for directions or information to be repeated if not understood or remembered.					
• Keep oral directions short and simple.					
• Have the student repeat or paraphrase directions.					
• Provide visual aids such as written directions for assignments.					
• Provide over-learning through review and repetition.					
• Check understanding of concepts through practice and talk-alouds.					
• Provide immediate feedback.					
• Other (please indicate in the box below)					

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Short-Term Memory (Gsm).

	Never	Rarely	Sometimes	Often	Always
• Provide visual guides during oral presentations.					
• Provide lecture notes or arrange for peer-shared notes.					
• Provide study guide to be completed during pauses in presentation.					
• Seat the student in a location away from distractions in order to optimize attention.					
• Provide extra time to copy information.					
• Read written directions aloud.					
• Use graphic organizers to reinforce associations between concepts.					
• Other (please indicate in the box below)					

Other (please specify)

Page Break

Part II D. Fluid Reasoning (Gf)

Fluid Reasoning (Gf) is the type of thinking an individual may use when faced with a relatively new task that cannot be performed automatically; a problem solving type of intelligence.

- A. I perceive my level of knowledge regarding the relationship of Fluid Reasoning (Gf) to academic learning as:
  - Low
  - Somewhat Low
  - Moderate
  - Somewhat High
  - High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to this Fluid Reasoning (Gf).

	Never	Rarely	Sometimes	Often	Always
• Teach problem-solving techniques in the contexts in which they are most likely to be applied.					
• Provide over-learning through repetition and multiple review of concepts.					
• Use concrete objects and manipulatives to develop conceptual understanding.					
• Use metacognitive skills, such as reflective discussions, thought journals, and self-questioning techniques.					
• Use think-alouds, guided practice, and feedback.					
• Use multiple and complex systems of retrieval and integration, such as compare, classify, abstract, induce, deduct, analyze perspectives.					
• Monitor for understanding.					
• Other (please indicate in the box below)					

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to this Fluid Reasoning (Gf).

	Never	Rarely	Sometimes	Often	Always
• Provide assistance in a timely manner.					
• Provide assistance with functions throughout a task such as when there are changes in task demands.					
• Use graphic organizers to analyze relationships, such as cause and effect, compare and contrast, classification schemes, and sequential order.					
• Seat the student next to a peer helper who can provide assistance.					
• Other (please indicate in the box below)					

Other (please specify)

Page Break

Part II E. Auditory Processing (Ga)

Auditory Processing (Ga) is the ability to perceive, analyze, & synthesize patterns among auditory stimuli (sounds) and to discriminate subtle nuances in patterns of sound and speech when presented under distortion conditions.

- A. I perceive my level of knowledge regarding the relationship of Auditory Processing (Ga) to academic learning as:
  - Low
  - Somewhat Low
  - Moderate
  - Somewhat High
  - High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to Auditory Processing (Ga).

	Never	Rarely	Sometimes	Often	Always
• Provide direct explicit, systematic instruction.					

	Never	Rarely	Sometimes	Often	Always
• Provide phonological awareness activities such as rhyming, alliteration, imitation, songs.	○	○	○	○	○
• Provide explicit instructions in sound discrimination, blending, and segmentation.	○	○	○	○	○
• Emphasize sound-symbol associations when teaching decoding and spelling.	○	○	○	○	○
• Provide visual aids, such as notes or study guides for listening activities.	○	○	○	○	○
• Provide assistance with note taking.	○	○	○	○	○
• Accompany oral information with visual materials.	○	○	○	○	○
• Check for comprehension after directions are given	○	○	○	○	○
• Other (please indicate in the box below)	○	○	○	○	○

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Auditory Processing (Ga).

	Never	Rarely	Sometimes	Often	Always
• Provide a well managed classroom with control of extraneous activities that create auditory distractions and competing background noise.	○	○	○	○	○
• Provide a peer assistant or buddy to assist with information when the student does not understand an oral communication.	○	○	○	○	○
• Provide preferential seating that supports monitoring of student comprehension.	○	○	○	○	○
• Other (please indicate in the box below)	○	○	○	○	○

Other (please specify)

Page Break

Part II F. Processing Speed (Gs)

Processing Speed (Gs) is the ability to fluently and automatically perform cognitive tasks, especially when under pressure to maintain focused attention and concentration.

- A. I perceive my level of knowledge regarding the relationship of Processing Speed (Gs) to academic learning as:
  ○ Low ○ Somewhat Low ○ Moderate ○ Somewhat High ○ High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to Processing Speed (Gs).

	Never	Rarely	Sometimes	Often	Always
• Provide oral discussions.	○	○	○	○	○
• Provide activities to increase rate and fluency, such as flash cards or speed drills through educational software.	○	○	○	○	○
• Provide strategies that improve the rate of task completion	○	○	○	○	○
• Encourage the student to self-monitor progress, such as graph for reading fluency, writing fluency, and math computation fluency.	○	○	○	○	○
• Other (please indicate in the box below)	○	○	○	○	○

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Processing Speed (Gs).

	Never	Rarely	Sometimes	Often	Always
• Shorten directions.	○	○	○	○	○

Provide lecture outlines such as a formatted script of notes in which only key words need to be added.					
Limit or structure copying activities.					
Consider individualizing test taking, such as small group.					
Provide extra time to read the test.					
Provide extra time for processing.					
Provide extra time to complete assignments.					
Other (please indicate in the box below)					

Other (please specify)

Page Break

Part II G. Visual Processing (Gv)

Visual Processing (Gv) is the ability to think about & generate, perceive, analyze, synthesize, store, retrieve, manipulate, transform, and think with visual patterns & visual stimuli.

- A. I perceive my level of knowledge regarding the relationship of Visual Processing (Gv) to academic learning as:
  - Low
  - Somewhat Low
  - Moderate
  - Somewhat High
  - High

B. Please indicate the extent to which you recommend the following possible instructional interventions related to Visual Processing (Gv).

	Never	Rarely	Sometimes	Often	Always
Provide multisensory learning using visual, kinesthetic, vocal, and auditory channels.					
Use manipulatives during instruction.					
Use language to describe visual forms of information as they are manipulated.					
Provide copying, tracing, and drawing activities.					
Provide verbal description of graphics and visually-based concepts.					
Use color coding to illustrate steps.					
Other (please indicate in the box below)					

Other (please specify)

C. Please indicate the extent to which you recommend the following possible accommodations related to Visual Processing (Gv).

	Never	Rarely	Sometimes	Often	Always
Provide spatial and sequential guides.					
Provide visual markers to indicate starting location and organization.					
Provide graphic organizers to organize information.					
Other (please indicate in the box below)					

Other (please specify)

Page Break

Thank You!

Thank you so much for participating in this study.

Cara Mackey Proctor, M.A.

If you are an educational diagnostician in the state of Texas and you would be willing to participate in a 60 to 90 minute focus group activity, please provide contact information so that a consent form can be provided. Please contact the researcher Carla Mackey Proctor for questions and concerns.

(1000 characters remaining)

Would you like to receive a copy of the survey results? If you would, please provide contact information so that a copy of the survey results can be provided.

(1000 characters remaining)

Would you like to receive a revised copy of the "Linking CHC to Intervention Tool" (Proctor & Albright, 2010)? If so, please provide contact information so that a copy of the "Linking CHC to Intervention Tool" can be provided.

(1000 characters remaining)

Continue ONLY when finished. You will be unable to return or change your answers.

Submit

powered by www.psychdata.com

APPENDIX E

MEMBER PARTICIPATION APPROVAL

Texas Professional Educational Diagnosticians
Board of Registry

February 1, 2010

Texas Woman's University
Institutional Review Board
Box 425619, TWU Station,
Denton, TX 76204

Dear IRB Committee Members:

This letter is to inform you that Carla Proctor has been granted permission by the Texas Professional Educational Diagnosticians Board of Registry to conduct the following survey as part of her Dissertation.

Title of Dissertation Study:
Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Purpose of Survey:
This survey explores the extent that educational diagnosticians possess knowledge of Cattell-Horn-Carroll (CHC) theory of cognitive ability and its relationship to academic learning, the extent that educational diagnosticians recommend possible evidence-based instructional interventions based on CHC theory, and the extent that educational diagnosticians recommend accommodations based on CHC theory.

If you have any questions you may contact me at: ______________________.
I look forward to receiving a copy of the study results.

Sincerely,

Tarey Tarleton 1/30/10

Tarey Tarleton
Board of Registry Chair
Texas Professional Educational Diagnosticians

APPENDIX F

PARTICIPANT RECRUITMENT LETTER

February 9, 2010

As part of my doctoral dissertation requirements at Texas Woman's University, I, Carla Proctor, am seeking volunteers to participate in a study, *Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations,* regarding research of educational diagnosticians' perceptions of knowledge and use of recommended instructional interventions and accommodations based on the link of cognitive theory to academic learning.

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. *G* factors of cognitive ability as presented in Cattell-Horn-Carroll (CHC) theory have been linked to academic difficulties experienced by children with learning disabilities. An ability-oriented evaluation consists of assessment that focuses on understanding a student's cognitive ability to process information and includes CHC factors that facilitate academic learning. Learning disability is caused by inherent weaknesses underlying cognitive processes. These cognitive process abilities are interrelated with academic abilities. Therefore, the design of an ability-oriented evaluation helps formulate the problem and determine specific instructional interventions and accommodations (Flanagan & Harrison, 2005, p. 274).

These instructional interventions are specific evidenced-based instructional practices designed to help support the relationship between *G* factors of cognitive ability and academic learning. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3). These accommodations provide support that helps the student access instruction and curriculum for academic learning. Instructional accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71).

A link to the survey is provided below. By clicking on the hyperlink, participants will be given specific directions for completion of the survey. Participation is voluntary. As with all information transmitted electronically, there is a potential risk of loss of confidentiality in all email, downloading, and internet transactions. Additionally, participants' confidentiality will be protected to the extent that is allowable by the law. Texas Woman's University Institutional Review Board has granted approval for this study.

Upon completion of the survey, participants will have an opportunity to receive a 2010 revised *Linking CHC to Intervention Tool* (Proctor & Albright, 2010). This tool provides educational diagnosticians with an explanation of the definition of each *G* factor of cognitive ability according to CHC theory, related achievement normative weaknesses, the relationship of each *G* factor to academic learning, recommended evidenced-based instructional interventions, and recommended instructional accommodations.

If you or any of the participants have questions about this study, I can be contacted at . My research advisors are Joyce Rademacher, Ph.D. and Tammy L. Stephens, Ph.D. They can be contacted at

Survey link:

https://www.psychdata.com/s.asp?SID=132459

Upon completion of the survey, participants may voluntarily choose to become a participant in a focus group by responding to the following question on the survey. "If you are an educational diagnostician whose primary assignment is located with a school district in the state of Texas, would you be willing to participate in a 60 to 90 minute focus group activity? Please indicate your choice by choosing the response that is appropriate for you. If you choose "Yes" please provide contact information so that a consent form can be provided." The date of each of the focus group meetings will be between February 1st and February 15th

Participants in this study will be interacting with the principal investigator and contributing information about their knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. Possible risks of participation include fatigue and physical discomfort. To prevent the potential risks involved in this study, safeguards will be in place to assure the participant's comfort. For example, participants may request breaks, or discontinue answering questions at any time. Water, beverages, and food will be available to participants during the focus group.

Another potential risk of participation in this study is release of confidential information. There is a potential risk of loss of confidentiality in all email, downloading and internet transactions. Steps will be taken to ensure that confidentiality is protected to the extent that is allowed by law. To ensure confidentiality in regards to providing this consent form, the researcher took the following precautions: Participants who indicated that they would be willing to participate in one of the three focus groups and who provided contact information were placed on a list for assignment of contact information with a code name and number. Code names consisted of *participant one, participant two, participant three*, etc. A second list was made that consisted only of assigned code names, numbers and contact information. The second list contained no identifying names with contact information. Upon completing the second list of assigned code names, numbers and contact information, the first list of identifying names with contact information was immediately destroyed. Thus, the investigator was left with one list consisting of code names, numbers and contact information.

To further ensure confidentiality, each of the three focus groups will be conducted at a conference room in a regional Education Service Center and will be closed to anyone who has not provided written consent prior to participation. Rather than using a participant's real name for information collected, a code name will be created and used on the investigators focus group written transcripts. The code name will be the name of a flavor of candy such as peppermint, chocolate, caramel, etc. The purpose of the code name will allow the investigator to organize, retrieve, and analyze data, while maintaining confidentiality.

Loss of anonymity is another potential risk and will be safeguarded by the following measures: Upon arriving at the focus group session, each participant will be assigned a code name for the purposes of the written transcript and for being referred to when responding or asking questions. Additionally, cards with code names will be placed in a designated seating position. Once each participant is assigned a code name, the participant will match the code name to corresponding seat and will take assigned seating position. This process will allow the investigator to refer to the participant during the course of the focus group session in code name only. The code names assigned for this purpose will consist of flavors of candy such as peppermint, chocolate, caramel, etc. The investigator will note responses and questions from all participants in the written transcript by assigned code name of individual participants. The purpose of the written transcript is to record data and information from the focus group session so that at a later date the investigator will be able to analyze and report the information as part of her dissertation.

Additionally, no audio or video recordings of any kind will be used during the course of this study. Any information provided by participants or related to this study will be secured in a locked file cabinet only accessible to the investigator and located in the investigator's private home study. All materials, including files and notes generated in this study will be destroyed August 15, 2010 following research completion through shredding and discarding. Computer thumb-drive and data containing any information related to this study will be erased.

A further potential risk is the loss of time. The survey may be completed at leisure. Each of the focus groups will be scheduled so as not to interrupt work/business schedule to the maximum degree possible. Each of the focus groups will be conducted at a conference room in a regional Education Service Center during available times after the educational diagnostician's work hours. The regional Education Service Center location of the focus groups will be determined based on the region that has the most participant volunteers.

Upon completion of the survey, participants will have an opportunity to indicate a choice to receive results of the survey by responding to the following question on the survey. "Would you like to receive a copy of the survey results? If you choose 'Yes' please provide contact information so that a copy of the survey results can be provided." Participants who complete the survey and provide contact information will receive results of the survey.

If you have any questions at any time about the research study you should ask the researchers; their phone numbers are at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

Thank you,

Carla Mackey Proctor, M.A.

APPENDIX G

CONSENT TO PARTICIPATE IN RESEARCH

Texas Woman's University
Consent to Participate in Research

Dissertation Study Title: Educational Diagnosticians' Perceptions on the Link Between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Investigator: Carla Proctor, M.A. ....

Advisors: Joyce Rademacher, Ph.D. ....
Tammy Stephens, Ph.D. ....

Explanation and Purpose of the Research:

As part of Mrs. Proctor's doctoral dissertation requirements at Texas Woman's University, she is seeking volunteers to participate in a study regarding research in educational diagnosticians' attained knowledge of linking Cattell-Horn-Carroll (CHC) theory to interventions based on professional preparation experience. Professional preparation is provided to educational diagnosticians in response to legal updates concerning eligibility criteria of learning disability. The purpose of this study is to gain information about the knowledge level of educational diagnosticians regarding an important competency: how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

These instructional interventions are specific evidenced-based instructional practices designed to help support the relationship between *G* factors of cognitive ability and academic learning. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3)

These accommodations provide support that helps the student access instruction and curriculum for academic learning. Instructional accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71)

Research Procedures:

As a voluntary focus group participant, procedures will include questioning from the researcher directed towards individual participants and to the group. During the focus group, the principal investigator will ask questions about your degree of knowledge on what specific learning experiences were included in your educational diagnostician preparation that helps you link the relationship between cognitive ability and academic learning as presented in Cattell-Horn-Carroll (CHC) theory as an important competency for educational diagnosticians. The principal investigator will also ask what do you think are barriers that educational diagnosticians *currently* face when linking the relationship between cognitive ability and academic learning?

____
Participant's Initials

Potential Risks:

Participants in this study will be interacting with the principal investigator and contributing information about their knowledge and experiences with recommending possible instructional interventions and accommodations based on the relationship between cognitive ability and academic learning. To prevent the potential risks involved in this study, safeguards will be in place to assure your comfort. For example, you may request breaks, or discontinue answering questions at any time. Water, beverages, and food will be available to you during the focus group.

Another potential risk of participation in this study is release of confidential information. Steps will be taken to ensure that confidentiality is protected to the extent that is allowed by law. To ensure confidentiality in regards to providing this consent form, the researcher took the following precautions: Participants who indicated that they would be willing to participate in the focus group and who provided contact information were placed on a list for assignment of contact information with a code name and number. Code names consisted of *participant one, participant two, participant three*, etc. A second list was made that consisted only of assigned code names and numbers and contact information. The second list contained no identifying names with contact information. Upon completing the second list of assigned code names, numbers and contact information, the first list of identifying names with contact information was immediately destroyed. Thus, the investigator was left with one list consisting of code names and numbers and contact information.

To further ensure confidentiality, the focus group will be conducted in a conference room in the Dallas ISD Individual Evaluation, which will be closed to anyone who has not provided written consent prior to participation. Rather than using participant's real name on information collected, a code name will be created and used on the investigators focus group written transcripts. The code name will be the name of a flavor of candy such as peppermint, chocolate, caramel, etc. The purpose of the code name will allow the investigator as the moderator and the assistant moderator to organize, retrieve, and analyze data.

Loss of anonymity is another potential risk and will be safeguarded by the following measures: Upon arriving at the focus group session, you will be assigned a code name for the purposes of the written transcript and for being referred to when responding or asking questions. Additionally, cards with code names will be placed in a designated seating position. Once you are assigned a code name, you will match your code name to corresponding seat and will take assigned seating position. This process will allow the investigator to refer to you during the course of the focus group session in code name only. The code names assigned for this purpose will consist of flavors of candy such as peppermint, chocolate, caramel, etc. The investigator will note responses and questions from all participants in the written transcript by assigned code name of individual participants. The purpose of the written transcript is to record data and information from the focus group session so that at a later date the investigator will be able to analyze and report the information as part of her dissertation.

Any information provided by participants or related to this study will be secured in a locked file cabinet only accessible to the investigator and located in the investigator's private home study. All materials, including files and notes generated in this study will be destroyed August 15, 2010 following research completion through shredding and discarding. Computer thumb-drive and data containing any information related to this study will be erased.

Approved by the
Texas Woman's University
Institutional Review Board
Date: 2-4-10

____
Participant's Initials

A further potential risk is the loss of time. Focus group participation is voluntary. The focus group will be scheduled so as not to interrupt work/business schedule to the maximum degree possible. The focus group will be conducted in a conference room in the Dallas ISD Individual Evaluation, during available times after the educational diagnostician's work hours. The date of the focus group meetings will be between February 1st and February 20th. There are no conflicts with room reservations nor are there any availability issues as the room is reserved on an on-going basis for Individual Evaluation.

There will be no pressure for you to answer questions or engage in conversation if you choose not to. You are under no obligation to become part of this study, or remain a volunteer once the study begins.

The researchers will try to prevent any problem that could happen because of this research. You should let the researchers know at once if there is a problem, and we will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

It is anticipated that the results of this study will be used in publication to serve as the investigator's dissertation; as well, results will be used in publications. The investigator ensures that all information used in publications will protect your confidentiality. Your name will not be used.

Participation and Benefits:

Time commitment for participants in the focus group is estimated to be 60 to 90 minutes. The estimated time for completion of the survey is approximately 30 to 45 minutes. Total committed time for completion of the survey and participation in the focus group is 90 to 135 minutes. The survey can be completed at participant's leisure and the focus group will be scheduled so as not to interrupt participant's work/business schedules.

Upon request, you will be provided a summary of the research results. If you would like a copy of the summary, provide your contact information at the end of this form.

Questions Regarding the Study

You will be given a copy of this signed and dated consent form to keep. If you have any questions at any time about the research study, you should ask the researchers; their phone numbers are at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

_______________________________ _______________________

Signature of Participant Date

Please provide your contact information below if you would like to receive a copy of this study upon completion:

____

____

____

Approved by the
Texas Woman's University
Institutional Review Board
Date: 2-4-10

APPENDIX H

LOCATION OF FOCUS GROUP APPROVAL

Michael Hinojosa, Ed.D.
Superintendent of Schools

Dallas Independent School District

January 11, 2010

Texas Woman's University
Institutional Review Board
Box 425619, TWU Station,
Denton, TX 76204

Dear IRB Committee Members:

This letter is to inform you that Carla Proctor has been granted permission to conduct a focus group meeting as part of her doctoral dissertation study in one of the conference rooms of Dallas ISD Individual Evaluation 912 Ervey Dallas, TX 75201.

Title of Dissertation Study:
Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Purpose of Focus Group Meeting:
This focus group meeting explores educational diagnosticians' perceptions regarding their training and/or preparation programs and knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory.

If you have any questions you may contact Karen Jones or Harrian Stern at: (972) 581-4200. We look forward to receiving a copy of the study results.

Sincerely,

Karen Jones

Karen Jones, M.Ed.
Director of Individual Evaluation
Department of Special Education
Dallas Independent School District

Harrian Stern

Harrian Stern, Ph.D
Supervisor of Educational Diagnosticians
Individual Evaluation
Department of Special Education
Dallas Independent School District

APPENDIX I

FOCUS GROUP QUESTIONS

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Focus Group Question #1A

PROMPT
Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

QUESTION
Think back on the variety of ways you acquired knowledge and skills on the relationship between cognitive ability factors and academic learning reflected in the CHC theory. How did you acquire the knowledge and skills for linking cognitive ability factors with academic learning?

Focus Group Member Rating and Voting for Question #1A

Linking the relationship between cognitive ability factors and academic learning

Rate how important each category is to you.

	Not Very Important			to	Very Important		
1. ______________	1	2	3	4	5	6	7
2. ______________	1	2	3	4	5	6	7
3. ______________	1	2	3	4	5	6	7
4. ______________	1	2	3	4	5	6	7
5. ______________	1	2	3	4	5	6	7
6. ______________	1	2	3	4	5	6	7
7. ______________	1	2	3	4	5	6	7
8. ______________	1	2	3	4	5	6	7

Vote on your top most important categories.

1st Most Important Category is ___________.

2nd Most Important Category is ___________.

3rd Most Important Category is ___________.

4th Most Important Category is ___________.

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Focus Group Question #1B

PROMPT

You just described the specific learning experiences that help you link the relationship between cognitive ability factors and academic learning.

QUESTION

What would have better prepared you to link the relationship between cognitive ability factors and academic learning?

Focus Group Member Rating and Voting for Question #1B

Better preparation for linking the relationship between cognitive ability factors and academic learning

Rate how important each category is to you.

	Not Very Important			to	Very Important		
1. ____________	1	2	3	4	5	6	7
2. ____________	1	2	3	4	5	6	7
3. ____________	1	2	3	4	5	6	7
4. ____________	1	2	3	4	5	6	7
5. ____________	1	2	3	4	5	6	7
6. ____________	1	2	3	4	5	6	7
7. ____________	1	2	3	4	5	6	7
8. ____________	1	2	3	4	5	6	7

Vote on your top most important categories.

1st Most Important Category is __________.

2nd Most Important Category is __________.

3rd Most Important Category is __________.

4th Most Important Category is __________.

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Focus Group Question #2A

PROMPT

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3).

QUESTION

Think back on the variety of ways you acquired knowledge and skills of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible instructional interventions do you currently recommend based on CHC theory?

Focus Group Member Rating and Voting for Question #2A

Possible instructional interventions recommended based on the relationship between cognitive ability factors and academic learning

Rate how important each category is to you.

	Not Very Important			to	Very Important		
1. ______________	1	2	3	4	5	6	7
2. ______________	1	2	3	4	5	6	7
3. ______________	1	2	3	4	5	6	7
4. ______________	1	2	3	4	5	6	7
5. ______________	1	2	3	4	5	6	7
6. ______________	1	2	3	4	5	6	7
7. ______________	1	2	3	4	5	6	7
8. ______________	1	2	3	4	5	6	7

Vote on your top most important categories.

1st Most Important Category is __________.

2nd Most Important Category is __________.

3rd Most Important Category is __________.

4th Most Important Category is __________.

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Focus Group Question #2B

PROMPT

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. These accommodations provide support that helps the student access instruction and curriculum for academic learning. Accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71).

QUESTION

Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What possible accommodations do you currently recommend based on CHC theory?

Focus Group Member Rating and Voting for Question #2B

Possible accommodations recommended based on the relationship between cognitive ability factors and academic learning

Rate how important each category is to you.

	Not Very Important			to	Very Important		
1. ______________	1	2	3	4	5	6	7
2. ______________	1	2	3	4	5	6	7
3. ______________	1	2	3	4	5	6	7
4. ______________	1	2	3	4	5	6	7
5. ______________	1	2	3	4	5	6	7
6. ______________	1	2	3	4	5	6	7
7. ______________	1	2	3	4	5	6	7
8. ______________	1	2	3	4	5	6	7

Vote on your top most important categories.

1st Most Important Category is ___________.

2nd Most Important Category is ___________.

3rd Most Important Category is ___________.

4th Most Important Category is ___________.

Educational Diagnosticians' Perceptions on the Link between CHC Theory and Recommendations of Instructional Interventions and Accommodations

Focus Group Question #3

PROMPT

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

QUESTION

Think back on the variety of ways you acquired knowledge of how to make recommendations of possible instructional interventions based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory. What barriers do you encounter when linking CHC theory to academic learning?

Focus Group Member Rating and Voting for Question #3

Barriers experienced when linking CHC theory to academic learning

Rate how important each category is to you.

	Not Very Important			to			Very Important
1. ______________	1	2	3	4	5	6	7
2. ______________	1	2	3	4	5	6	7
3. ______________	1	2	3	4	5	6	7
4. ______________	1	2	3	4	5	6	7
5. ______________	1	2	3	4	5	6	7
6. ______________	1	2	3	4	5	6	7
7. ______________	1	2	3	4	5	6	7
8. ______________	1	2	3	4	5	6	7

Vote on your top most important categories.

1st Most Important Category is __________.

2nd Most Important Category is __________.

3rd Most Important Category is __________.

4th Most Important Category is __________.

APPENDIX J

FOCUS GROUP DISCUSSION PROTOCAL

FOCUS GROUP DISCUSSION PROTOCOL

Thank you for agreeing to participate in my dissertation research study. We want to hear your ideas about how prepared you believe you are in recommending possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning. Knowledge of these recommendations is acquired through a variety of professional development formats. Your ideas are valuable to us because it will inform us as well as others in the field of evaluation.

Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. G factors of cognitive ability as presented in Cattell-Horn-Carroll (CHC) theory have been linked to academic difficulties experienced by children with learning disabilities. An ability-oriented evaluation consists of assessment that focuses on understanding a student's cognitive ability to process information and includes CHC factors that facilitate academic learning. Learning disability is caused by inherent weaknesses underlying cognitive processes. These cognitive process abilities are interrelated with academic abilities. Therefore, the design of an ability-oriented evaluation helps the educational diagnostician formulate the problem and determine specific instructional interventions and accommodations (Flanagan & Harrison, 2005, p. 274).

These instructional interventions are specific evidenced-based instructional practices designed to help support the relationship between G factors of cognitive ability and academic learning. Evidence-based instructional practices are "practices that are informed by research, in which the characteristics and consequences of environmental variables are empirically established and the relationship directly informs what a practitioner can do to produce a desired outcome" (Dunst, Trivette, & Cutspec, 2002, p. 3)

These accommodations provide support that helps the student access instruction and curriculum for academic learning. Instructional accommodations are "services or supports that [are] provided to help a student fully access the subject matter and instruction as well as to demonstrate what he or she knows" (Nolet & McLaughlin, 2000, p. 71)

Knowledge of how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians. Knowledge of these recommendations is acquired through a variety of professional development formats. These formats include, but are not limited to staff development, university-based coursework, independent study, alternative certification programs, etc.

Before we pose the Focus Group questions, we want you to think about some of the recommendations that you have included in your FIE's and ARDs. To prompt your thinking, a copy of the *Linking CHC to Intervention Tool* (Proctor & Albright, 2010) will be provided for reference.

(Distribute *Linking CHC to Intervention Tool*)

We will be using a research methodology called *Metaplan* to gather your ideas. A handout of *The Metaplan Steps* is inside your folder. Let's review these steps together.

<u>The Metaplan Steps</u>

Step 1 A question is stated.

Step 2 Participants write thoughts and feelings on note cards.

Step 3 Participants write clearly and neatly.

Step 4 Write one idea per card.

Step 5 Use 7 words or less if possible

Step 6 The investigator as the moderator and the assistant moderator collects and reads note-cards aloud and displays them on the wall.

Step 7 The investigator as the moderator, the assistant moderator, and the participants organize the note cards into clusters or categories of thoughts, feelings, and opinions.

Step 8 Participants may continue writing their thoughts during the clustering process.

Step 9 The investigator as the moderator, the assistant moderator, and the participants discuss their thoughts, feelings, and ideas through the clustering process.

Step 10 The participants conclude the process by rating the categories according to how important they perceive it to be. They also rank their top categories according to perceived importance.

All of your comments are strictly confidential and will not be shared with anyone outside of this room. Your name will not be associated with the results in any way.

Now, we will model for you how to write your responses on your note cards. **(The moderator to pose this question: "Write down as many characteristics you can think of that describe your favorite learning environment." The assistant moderator will model how to write about 5 or six comments onto cards while "thinking out loud." The moderator will then collect the cards and show them to the group).**

Good, now that the procedure has been modeled, let's begin with our first question. (Turn to the yellow sheet in the folder for Question # 1). You will see that there is a prompt at the top of the page and that the question is stated below. Let's read the prompt together. The prompt states "Federal and State law requires that the identification of a learning disability only be considered when a student is not making progress in the general education curriculum after being provided with evidence-based classroom instruction. Knowledge on how to recommend possible instructional interventions and accommodations based on the relationship between cognitive ability factors and academic learning as presented in Cattell-Horn-Carroll (CHC) theory is an important competency for educational diagnosticians.

"Think back on the variety of ways you acquired knowledge and skills on the relationship between cognitive ability factors and academic learning reflected in the CHC theory. How did you acquire the knowledge and skills for linking cognitive ability factors with academic learning?" Write as many thoughts as you can think of onto the color-coordinated yellow sticky note cards. When you are finished, we will post and discuss the responses on the cards. You may begin. ***Wait until most participants are ready, and then begin to post the cards. When similar***

responses are noted, post them together in a group. Once all responses are posted, give each set of responses a category name.

Now locate the "Focus Group Member Rating and Voting Section for Question #1" that is located in the mid-section of the yellow page. ***Tell participants to write the name of each category on the lines provided. Ask participants to circle a number (1-7) according to how important they believe the category is to them.***

Next, tell participants to look at the bottom section of the yellow sheet. Ask them to list the categories they believe are most important by recording the names of the categories from most important to least important. (You will determine the number of categories designated and then divide by 2. That is the number of categories each person should list.)

Continue to Questions #1B through 3A in the same format.

(Post, cluster, and vote as with the other questions.)

In closing, thank everyone for participating and collect materials.

APPENDIX K

FOCUS GROUP RESULTS

Focus Group Results

Focus Group Question #1A-Most Important Category				
#	Category	Category 1	Category 2	Category 3
1	Lit Review	2		2
2	School Base			1
3	Technology	1		1
4	Collaboration		4	
5	Prof. Dev.	2	1	1

Focus Group Question #1B-Most Important Category				
#	Category	Category 1	Category 2	Category 3
1	Formal Univ. Training	3	1	
2	Advance Professional Dev.	2	1	2
3	Formal Teacher Training		2	
4	Case Studies			1
5	Collaboration		1	2

Focus Group Question #2A-Most Important Category				
#	Category	Category 1	Category 2	Category 3
1	Decoding	1	1	
2	Manipulatives			
3	Customized	1		
4	Vocabulary	2	1	1
5	Visual Aids		3	
6	Memory/Retrieval	1		4

Focus Group Question #2B-Most Important Category				
#	Category	Category 1	Category 2	Category 3
1	Visual	3		1
2	Writing Alternatives		2	1
3	Testing			
4	Environmental Acc.			2
5	Time	2		1
6	Oral		3	

Focus Group Question #3-Most Important Category				
#	Category	Category 1	Category 2	Category 3
1	Application	4	1	
2	Cultural/Language	1	1	1
3	School Issues		1	
4	Time			2
5	Communication		2	2