A Paradigm Shift in Classroom Learning Practices to Propose Methods Aligned with a Neuroeducation Conceptual Framework

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with a Neuroeducation Conceptual Framework

by

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Abstract

The overall purpose of this study was to propose an alignment between the research reported in the literature on language acquisition and language function and how that research is represented in current literacy practices. This study considered neuroscience, which can provide critical insights into how children learn, alongside theories of cognitive psychology, which help educators understand how children learn to think. Overlapping neuroscience and cognitive psychology, language both represents thinking and mediates thinking; a critical component for literacy acquisition. The study both develops and recommends a paradigm shift in classroom learning practices that are aligned to Arwood’s Neuroeducation theoretical framework.

The literature was triangulated through the overlap of language theory, cognitive psychology, and neuroscience to explore and develop neuroeducation definition for language, language acquisition, learning and their impact upon the acquisition of literacy processes. Four questions were addressed. First, common instructional practices were identified and analyzed, finding behaviorism and cognitive psychology as the dominant theories underlying prevalent literacy instructional practices. Next, an examination of the literature provided evidence to identify tenets aligning with neuroeducation. Third, transcribed interactions between students and teacher in a second grade classroom were analyzed and coded using the three lenses of neuroeducation. The coding cycles determined that conceptual elements identified
within the review of literature could also be found in classroom practice. Finally, nine years of reading data (Developmental Reading Assessment) from a teacher in a first grade environment based upon language acquisition and neuroscience from a low-income, high English Language Learner population was analyzed; after year three, 90% or more students met or exceeded district proficiency levels, demonstrating the efficacy of the neuroeducation model.

The study adds to the literature by delineating language function versus language structure in classroom practice. This research adds to the emerging field of neuroeducation by introducing the impact of the acquisition and function of language on the development of the function and structures of the brain. This study also provides data demonstrating the efficacy of a neuroeducation based learning environment. This research recommends neuroscience and language theory become part of future teacher education programs for future systemic change.
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Fifteen years ago, I had the privilege of taking a class from Dr. Ellyn Arwood, and my personal and professional life has never been the same. As my doctoral chair, she has encouraged, cajoled, pushed, prodded, suggested, and read innumerable pages of my writing while steering me through this complex process of scholarship. I am forever in your debt.

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Finally, I appreciate each one of the doctoral students who have made this crazy journey as the first cohort along with me. We are all evidence of the power of the process of learning as we have argued, agonized, and acquired new information together. I know what we have contributed as a group will make a lasting impact upon our profession and upon each other.
Dedication

The scope of this project would not have been possible without the love of my life, my amazing husband Mark. From the first day until the last, he has been a support, my rock, sounding board, editor, graphic designer, video editor, tech support and shoulder to cry on. If there was an honorary doctorate for learning and reading almost as much as a doctoral student, he has earned it, with honors. Thank you my love…this would not have been possible without you.
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Chapter 1

Introduction

The information provided in Chapter One includes a brief overview of the current research proposal in order to provide a succinct framework for the study. There will be a short background to provide context for the research, then a brief description of the conceptual frameworks explored in depth in Chapter Two, problem statements and research purpose, and a preview of the methods section of Chapter Three. The following section begins with the background of the study, which provides context for why the researcher began to ask questions relevant to the current study.

The purpose of this study is to propose an alignment between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, and calculating) practices in order to develop and recommend a paradigm shift in classroom learning practices that are aligned to the neuroeducation conceptual framework.

Background

“The learning of language will be interpreted as the learning of a system of meanings. A child who is learning his first language is learning how to mean” (Halliday, 1975, p. 8).

There are many reasons why the acquisition of language function should hold an important place in the educational system. Language is both learned and is the foundation of future learning, because without language one cannot interact is a social
way to receive information (Bernstein, 1964; Mitka, 2010). Without the use of language, a learner cannot acquire the information needed to understand what is being taught in school. Indeed, language function in young children is predictive of later academic success (Hart, 1995; Hayiou-Thomas, Harlaar, Dale, & Plomin, 2010). However, language function is not a part of the usual curricula in the classroom nor is it part of the professional understanding of the average teacher (Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005; Yatvin, Weaver, & Garan, 2003). Language function is the foundation for literacy when literacy is defined as, the language functions and structures of reading, writing, thinking, listening, speaking, viewing, and calculating (Cooper, 2006). The impact of language function on acquiring the psychological processes of reading, writing, thinking, listening, speaking, viewing, and calculating is overlooked in daily instruction of the elementary (K-5) classroom, although learners are still in the process of acquiring a full language system in the elementary grades (Arwood, 2011; Clark, 1977; Halliday, 1977).

Language

“Thought development is determined by language…by the linguistic tools of thought and by the sociocultural experience of the child…the child’s intellectual growth is contingent on his mastering the social means of thought, that is, language” (Vygotsky, 1962, p. 51).

During the past fifteen years, there has been no widespread acknowledgement of the impact of language function on literacy processes. However, there is strong evidence that when a child is lacking in language development and function, a life-long gap can develop that translates into struggles with academic achievement (Bull, Espy, & Wiebe, 2008; de Abreu et al., 2014; Hart, 1995; Hayiou-Thomas et al., 2010).
If language is representative of thinking and fundamental for all learning processes (Arwood, 1983; Bruner, 1975; Carroll, 1964; Dore, 1975; Halliday, 1977; Searle, 1970), more opportunities for language acquisition in the classroom may be needed for children struggling with acquiring literacy processes.

Many learners have difficulties with the acquisition of literacy processes (reading, writing, listening, thinking, speaking, and calculating) within the current educational system. Dyslexia, dysgraphia, auditory processing disorders, ADHD, and autism are diagnostic labels given to learners that have increased over the past decade (Gabrieli, 2009; Getahun et al., 2013; Mitka, 2010). Moreover, current results from the National Assessment of Educational Progress, often referred to as the Nation’s Report Card, find that only 36% of fourth graders are considered proficient in reading, and 40% are considered proficient in mathematics (National Center for Education Statistics & Hager Sharp, 2013). The increase in learners who show difficulties accessing literacy processes in the current educational system may be evidence of current paradigms (thinking) about teaching and learning which do not align with what is currently known about the impact of neurobiological learning system and language function upon the process of learning.

**Neuroscience**

“*Linguistics is the study of language. Language is a system of brain circuits....if linguistics is the study of language and language is in one sense a system of brain circuits, one would expect linguists to be open to the study of brain circuits*” (Pullum, 2002, p.270).

While language acquisition in children who struggle in school has been downplayed, neuroscience has made strides in understanding the processes of learning
as a neurobiological function. Imaging studies (fMRI, PET, etc.) allow neuroscientists to examine the relationship between tasks and brain activity as well as to track brain activity during various tasks. This type of research is demonstrating a strong relationship between language function and brain function, through evidence of layers of highly interconnected neural networks showing strong activity during language tasks (Gallistel & Matzel, 2013; Götzmann & Schwegler, 2010; Pulvermüller, 2003, 2005, 2012).

**Cognitive Psychology**

“The proper reward of learning is that we can now use what we have learned, can cross the barrier from learning into thinking” (Bruner, 2006, p. 25).

The field of education has placed heavy emphasis on expanding a child’s *mind*. For example, there are current studies measuring perception, attention, motivation, effort, and self-regulation (Anderson, 2010; de Bruin & van Gog, 2012; Finn, Lee, Kraus, & Hudson Kam, 2014; Lucas et al., 2014), which are all workings of the mind as determined by the interpretation of the outward behavior of a child. Recently, there has been a movement toward the integration of neuroscience and the mind of a child while in the process of education known as Mind, Brain, Education (MBE). Researchers from multiple disciplines are coordinating efforts to translate neuroscience research into effective classroom practices (Fischer, 2009; Immordino-Yang, 2011b; Pavani, Murray, & Schroeder, 2007; Sawyer, 2010). However, this translational pursuit is missing theories of language acquisition (Arwood, 2011), which could allow educators to explain the impact of language on the structures and
functions of the brain. Given the impact of language function on the acquisition of literacy processes (Bhattacharya, 2010; de Abreu et al., 2014; Hart, 1995; Hemphill & Tivnan, 2008; Judge, 2013), it would seem that language should be part of any translational effort between neuroscience and educational methodologies. However, the current paradigm that influences teaching and learning does not account for language function as a critical factor for access to literacy processes.

**Neuroeducation**

“What is called for is an extremely opened minded enquiry which takes nothing for granted from the vast accumulation of habits, assumptions, experience and research which surround the subject like an impenetrable jungle” (Holdaway, 1979 p.13).

There is a current framework for the translation of neuroscience into classroom literacy practices, which fully integrates the impact of language function on the learning process. Neuroeducation, as developed and defined by Dr. Ellyn Arwood of the University of Portland, is the overlap of cognitive psychology (mind), neuroscience (brain), and language theory. Arwood’s Neuroeducation is a new lens through which educators can begin to translate neuroscience research into classroom practice, and is currently appears to be the only conceptual framework within the evolving field of neuroscience and education that considers language as a mediating factor to connect what is known about the mind and the brain.
The triangulation of neuroscience (brain), contributions in the field of cognitive psychology (mind) and the impact of the function of language as it relates to the mind and the brain allows for a new theoretical framework, Arwood’s Neuroeducation for understanding the underlying mechanisms for all learning processes. For the remainder of this research, the word *neuroeducation* will be used in reference to Arwood’s Neuroeducation. Neuroeducation fully triangulates known literature regarding the brain, mind, and language, so this framework may provide an explanation for difficulties the current educational paradigm (thinking) has in regards to the learning needs of certain student populations. This study uses the neuroeducation framework to develop, analyze and then suggest a shift in classroom practices reflecting a neuroeducation paradigm.

There is scant evidence demonstrating widespread effectiveness of current classroom learning practices for children living in poverty, children learning English as a second language, and children with learning differences (Bean, Dole, Nelson,
Belcastro, & Zigmond, 2015; Gamse, Jacob, Horst, Boulay, & Unlu, 2008; National Center for Education Statistics & Hager Sharp, 2013). Children living in poverty, learning English as a second language and those with learning differences have demonstrated difficulty achieving academic parity with their age level peers in the acquisition of literacy processes (Bhattacharya, 2010; Hustad, Allison, McFadd, & Riehle, 2014; Judge, 2013; Skoe, Krizman, & Kraus, 2013; St Clair-Thompson & Gathercole, 2006). In addition, there is evidence that previously mentioned groups of children also struggle with functional language use and language acquisition (Dickinson & Porche, 2011; Goodman, 1972; Harlaar, Hayiou-Thomas, Dale, & Plomin, 2008; Hart, 1995; Hayiou-Thomas et al., 2010; Hoff, 2003; Pascalem, Neanderabreu, Carolineanikeado, & Marinapuglisi, 2014) thereby suggesting a link between the acquisition of language and literacy processes.

Therefore, it may be time for a new way of thinking regarding the acquisition of literacy processes (reading, writing, speaking, thinking, listening, calculating) that accounts for the neuroscience of learning, the thinking of the mind, and the learning of language that mediates literacy development. Within the current educational system, there are children with learning differences, such as English Language Learners, children diagnosed with learning disabilities, and children living with the realities of poverty, who are not given equal access to learning opportunities within the current educational system (Hurder, 1997; Kozol, 2005a; McLaughlin, 1995; Provenzo Jr, 2008; Rebell, 2012; Rioux & Pinto, 2010). This is evidenced by the gap between the achievement scores of the previously mentioned groups and children diagnostic labels.
(Bush, 2001; Gamse & National Center for Education Evaluation and Regional, 2008; National Center for Education, 2004; National Center for Education Statistics & Hager Sharp, 2013; Spencer, 2009). In addition, the National Assessment of Educational Progress (NAEP), often referred to as the nation’s report card, shows that only 40% of students across the nation are proficient in math and reading (National Center for Education Statistics & Hager Sharp, 2013).

The opportunity for all students to engage in the acquisition of literacy processes may ask educators to consider a neuroeducation lens to fully understand the learning process. The education system will need to consider neuroscience, which can provide critical insights into how children learn, alongside theories of cognitive psychology, which help educators understand how children learn to think. Overlapping neuroscience and cognitive psychology, language both represents thinking and mediates thinking, which then influences how children learn and how they learn to think. In this way, all children have equal access to the opportunities for learning within the educational system as educators understand and help children utilize their own neurobiological learning system. This study will consider the theoretical frameworks underlying neuroeducation in order to propose classroom practices aligned with neuroeducation for improved access to literacy processes for all children.
Statement of the Problem

There is a lack of alignment in the educational community between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, and calculating) practices. Vygotsky (1962) and other language theorists (Dewey, 1910; Fillmore, 1977; Halliday, 1977; Lucas, 1977) clearly demonstrate that children cannot be “taught” by simply imparting information. Instead, each child must form concepts by layering the multiple opportunities of language use and refinement with another. Vygotsky states, “Practical experience also shows that direct teaching of concepts is impossible and fruitless. A teacher who tried to do this usually accomplishes nothing but empty verbalism, a parrot-like repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum” (p. 85). The current paradigm (thinking) influencing curricula design and implementation represents a theoretical viewpoint supporting input/output response, modeling, imitation, learning targets, repetition, and early literacy experiences based upon the acquisition of sounds and letters. Current learning environments (Bean et al., 2015; Kozol, 2005a; Missett & Foster, 2015; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005), will continue to produce the same results that have occurred over the past decade, which are failing to provide an environment where all children have the opportunity to learn (Getahun et al., 2013; National Center for Education Statistics & Hager Sharp, 2013; Zampini & D’Odorico, 2013). The current paradigm influencing pedagogy also does not take into account the
way language acquisition affects language function for higher order thinking and better literacy. In addition, the current paradigm places an emphasis on teaching instead on the process of children learning to think, then naming their thinking with language. Considering the lack of consideration of literature regarding language theory and the design and implementation of literacy curricula, there is an apparent gap in the literature regarding a neuroeducation model of classroom literacy practices. The lack of alignment may be why the practices currently employed in the dominant educational paradigm may not be meeting the needs of all students (Dee & Jacob, 2011; National Center for Education Statistics & Hager Sharp, 2013). Perhaps a shift in thinking regarding teaching and learning is needed to allow more students access to the process of learning.

To create a neuroeducation model of literacy two specific concerns must be addressed:

1. *There is little acknowledgement of recent neuroscience research regarding the neurobiological process of learning in current literacy (reading, writing, thinking, listening, viewing, and calculating) practices.* For example, recent evidence from neuroscience research indicates that many learners cannot integrate acoustic patterns into their learning systems, and therefore cannot use sounds in the process of learning (Gage & Muotri, 2012; Stevenson, VanDerKlok, Pisoni, & James, 2011). However, the current educational system for early literacy acquisition is heavily based in the instruction of sounds and letters. School programs and educational philosophies that fail to
integrate the impact of the neurological learning system on the acquisition of language may not be providing meaningful learning opportunities for a large number of children (Gamse et al., 2008; National Center for Education Statistics & Hager Sharp, 2013).

2. *Current literacy practices do not provide for the integration of language theory and neuroscience represented by neuroeducation.* Although educators and neuroscientists have started collaborating on how to translate scientific findings into classroom practices through Mind, Brain, Education (MBE), there is no consideration of the impact of language on the processes of learning. There is a strong impact of language on all learning processes, so future translations from neuroscience research to classroom practices must consider language as an underlying factor for learning.

The next section will provide theoretical frameworks considered in the review of literature to support the use of neuroeducation as a lens for changes educational methodologies to better meet the learning needs of all learners. These frameworks include theories of language, language acquisition, and the neurobiological learning system as they relate conceptual background of neuroeducation. These theoretical frameworks will also provide the foundational for a theoretical shift in thinking (paradigm) regarding the process of learning in the elementary classroom.
Conceptual Frameworks

There are several theories regarding language and learning that may provide an explanation for the lack of widespread literacy processes acquisition by students within the current educational setting. In this section, there will be a discussion of Vygotsky’s (1962) social interactionism theory of language acquisition, recent evidence from neuroscience on the biological nature of learning, and a current theory regarding language and learning which integrates these theoretical constructs. Chapter Two will discuss these theories in more detail as they relate to the development of a neuroeducation model to literacy.

Vygotsky (1962) proposes a social interaction theory of learning describing concept formation as complex and unique to each individual. Each word represents a multilayer concept acquired through social interaction with peers and adults through the use of language, and, without this social interaction, no language would form and therefore, no concepts. Vygotsky (1962) also observed both that a child must use language to form concepts and that the use of language by the child represents their understanding of concepts. He also found that concept formation takes place over many years, with a child reaching the point of abstract (formal) thinking in early adolescence. Until early adolescence, children rely heavily on interaction with a person with more advanced language to create meaning for the process of acquiring concepts.

The synergy between acquiring concepts and social interaction is mirrored by the neurobiological processes involved in learning (Arwood, 2011). When sensory
input is recognized by receptors (eyes, ears, hands) neurons fire and begin to form perceptual patterns. Each person has a unique set of perceptual patterns due to their unique experiences with their sensory system (Baars, 2010). When the perceptual patterns begin to overlap through multiple opportunities to refine and label the patterns from an outside agent, the patterns, which are represented by single firing neurons, connect into circuits that represent a concept. As concepts begin to layer and connect to other concepts, the circuits develop into neural networks representing systems of concepts that represent language (Damasio & Geschwind, 1984; Gallistel & Matzel, 2013; Pulvermüller, 2003). Therefore, the use of language allows for the neurobiological growth of structures needed to fully access language.

The conceptual framework referred to as the Neurosemantic Language Learning Theory (NLLT) (Arwood, 2011) explains the connection between language and the brain. The NLLT explains that all learners have a unique neurobiological learning system that is used to process and acquire new information. The neurobiological learning system is dependent upon meaningful perceptual information in order to integrate the new information into neural networks representing language. However, social interaction through language (Bruner, 1975; Carroll, 1964; Halliday, 1977; Tomasello, 2004; Vygotsky, 1962) is needed to create the meaningful information for the acquisition of new concepts. The NLLT provide the theoretical framework to describe the synergy between the process of language acquisition and the neurobiological processes underlying the integration and inhibition of recognized
sensory information. With this conceptual framework, literacy becomes mediated by language acquisition and later by language function.

**Purpose of the Study**

The purpose of this study was to propose an alignment between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, calculating) practices in order to develop and recommend a paradigm shift in classroom learning practices that are aligned to the neuroeducation conceptual framework. A paradigm could be described as a concept accepted by most people in an intellectual community because of its effectiveness in explaining a complex process or idea (Merriam-Webster, 2004). Therefore, a paradigm shift could be described as change in one way of thinking to another way of thinking about a problem or issue. A paradigm shift regarding tenets influencing teaching and learning is suggested through this research because the current paradigm might not be meeting the educational needs of all learners (Arwood, 2011; Arwood & Robb, 2008; Nash, Hulme, Gooch, & Snowling, 2013; National Center for Education Statistics & Hager Sharp, 2013; Spencer, 2009; Zampini & D'Odorico, 2013). If the current dominant paradigm influencing decisions made regarding teaching and learning practices is not providing evidence of widespread effectiveness, perhaps a new way of thinking about learning is needed.

There is currently a research gap in the literature when considering a neuroeducation approach to literacy because language acquisition has not been
considered as a mediating factor in learning practices in education. Without an understanding of the neurobiological processes underlying the acquisition of literacy processes, educators could be asking learners to acquire new information in a way that stresses the neurobiological learning system, therefore inhibiting the acquisition of literacy. At the same time, educators may not recognize the importance of language acquisition on the conceptual learning process, thereby omitting critical conceptual language needed for the acquisition of literacy processes. The integration of the conceptual framework represented by neuroeducation requires a shift in thinking about the very nature of learning, language acquisition, and the function of language to name cognitive processes as they relate to classroom practices.

In order to propose a paradigm shift in classroom learning practices aligned to neuroeducation, four research questions are considered in this study:

1. What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?

2. What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?
3. How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy?

4. Can literacy data, collected from a classroom environment based upon language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift?

Chapter Two addresses these questions by connecting the research and theory from cognitive psychology, neuroscience and language to define language, language acquisition, and learning. There is an overview of the historical context of literacy (reading, writing, thinking, speaking, viewing, listening, and calculating) education in the United States in order to provide background for current literacy practices. Then the research examined in Chapter Two is divided into two parts: part one, the identification and examination of current paradigms regarding teaching and learning, part two, examination of literature regarding language and learning using the neuroeducation theoretical framework to suggest a new paradigm regarding teaching and learning. A discussion connecting the empirical evidence and theoretical frameworks regarding the connection between language function and literacy processes is provided in Chapter Two in order to support the construct validity for a paradigm shift regarding the acquisition of literacy processes.
Methods

The methods chosen for this study will focus on addressing the previously described research questions in order to propose a neuroeducation literacy model.

*What are the currently accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?* Current tenets regarding teaching and learning are clearly identified, available literature supporting the current tenets is identified, finally, the manifestation of current tenets with classroom practice are described. The purpose of this section is to examine what theoretical frameworks influence the current educational system, which are clearly identified within Chapter Two, in order to fully understand the research underlying the current educational paradigm, then to suggest a paradigm shift in teaching and learning which aligns with the neuroeducation framework.

*What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?* The tenets resulting from the paradigm shift evidenced from the neuroeducation based classroom setting are identified then current literature supporting tenets is examined. Finally, classroom practices developed from the alignment to the neuroeducation framework that matched each tenet are identified within a table.
How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy? The researcher recorded the classroom environment while engaged in language acquisition events in a second grade, urban classroom. The classroom learning events were designed using the theoretical framework provided by the NLLT and the lens of neuroeducation. This is a general education classroom in a public school with 27 students and one teacher. Methods based upon the NLLT are used to demonstrate classroom practices that provide evidence of the efficacy of a neuroeducation-based model for the acquisition of literacy processes. The transcription was coded using the conceptual frameworks of neuroeducation.

Can literacy data, collected from a classroom environment based upon language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift? This researcher has collected literacy data spanning nine years from classrooms representing over 250 students. The classroom literacy practices utilized during this time reflect a neuroeducation framework and the implementation of the Neurosemantic Language Learning Theory (NLLT). If the neuroeducation based model of teaching and learning theoretically valid, then all learners should demonstrate growth with the neuroeducation model. This researcher carefully examined both published (Arwood, 2011; Arwood & Robb, 2008) and unpublished historical data to fully describe the learning outcomes using mandated testing results from a classroom engaged in language acquisition processes
represented by the NLLT. The instructional practices utilized in this setting to provide all learners with access to literacy processes represent a paradigm shift that aligns with the neuroeducation conceptual framework. The instructional practices for the acquisition of literacy processes are described in order to examine and identify the paradigm shift represented by classroom practices attributed to the improved results on mandated summative assessments.

Overall, this research explored what theories of learning influence tenets in education today, how those tenets shift when matched to the literature, what the new tenets are evident in a neuroeducation based classroom, and the effectiveness of classroom practices based upon a paradigm shift to neuroeducation.

**Results**

The results of the methods developed for this study provided insights relating the four research questions posed in the methods section. First, a table analyzing current, prevalent, classroom practices indicate a strong theoretical influence related the cognitive sciences (Theory of Mind, linguistics, behaviorism), but lacking in language theory and neuroscience. A second table was completed which proposed new tenets from the literature representing a paradigm shift to neuroeducation. The researcher utilized the conceptual frameworks described in the review of literature to generate current tenets regarding learning in addition to tenets representing a paradigm shift to neuroeducation.

For research question three, the analysis transcription of classroom language events from a learning environment designed with the neuroeducation framework
indicates that there are ways to provide support for the acquisition of language and literacy processes for all students in the classroom setting. The researcher delineated specific learning practices within a neuroeducation designed learning event in order to analyze the practices for language theory and neuroscience principles through. The analysis was made through two cycles of coding that are discussed in Chapters Three and Four. Finally, the efficacy of a neuroeducation model for the acquisition of literacy processes was found through historical literacy data as cohorts of first graders in a low socio-economic school shifted from 60% of students at grade level in reading to 95% of students at grade level after the researcher implemented a neuroeducation design in the classroom. The results confirm a paradigm shift suggested from the literature: The integration of language theory and neuroscience are critical to provide access to learning for all students. The overlap of cognitive psychology, neuroscience, and language theory, represented by neuroeducation, allows the educator to provide all students with an environment for learning.

**Summary**

Neuroeducation provides a new lens from which to evaluate existing research on language, language acquisition and learning. This chapter provided background to explain the research gap in the current literature, which exists because interpretation of learning theories and empirical studies lean heavily on cognitive psychology. As a result of the emphasis on the mind, current classroom learning practices may not reflect the depth and complexity of conceptual learning, which has then led to the design of classroom practices that do not meet the needs of all learners.
In Chapter Two, this study addresses the research gap by using the lens of neuroeducation, which represents the overlap of conceptual underpinning of cognitive psychology, neuroscience, and language to provide translational perspective for current research. The literature review includes theories of language, language acquisition, language function, current and historical literacy practices, and the effect of language on the acquisition of literacy processes, examined using the three lens of neuroeducation. The purpose of Chapter Two is to provide the theoretical background to support a change in thinking (paradigm shift) regarding the pedagogy that currently influencing literacy instructional practices.

Chapter Three describes the methods utilized to fully explore the literature surrounding the current paradigms of teaching and learning, analyze historical data collected from a classroom using practices developed from the NLLT, and collect a replicable description of current effective classroom practices designed using the neuroeducation model. The triangulation of the information gained from these three perspectives will be used to propose a paradigm shift in classroom learning practices aligned with neuroeducation conceptual framework.

Chapter Four provides an analysis of the current paradigm influencing literacy practices, the results of the analysis of historical data, a transcription of the language used during neuroeducation based language events with analysis of the classroom practices using the three theoretical lenses of neuroeducation, and proposal of a model representing a paradigm shift from current learning practices. This model represents the triangulation of current research, historical data, and current neuroeducation based
literacy practices. The study concludes in Chapter Five with implications for future curricula design, theoretical models, teacher preparation programs, and ongoing teacher education based upon the findings of this research.
Chapter 2

Review of Literature

Chapter One provided an overview of the misalignment between current educational literacy practices and the cognitive psychology, neuroscience, and language acquisition literature used in neuroeducation translation. Furthermore, the use of literacy practices mandated by curricula reflecting the current paradigm surrounding teaching and learning have demonstrated limited wide spread positive effect on literacy processes in children. This Chapter, Review of Literature, provides the literature related to the misalignment, which leads to research questions investigated in the study in order to align practices used to help learners acquire literacy processes (reading, writing, speaking, listening, viewing, thinking and calculating) with learning theory.

The review of literature provides historical background for current literacy practices through the examination of the influences of cognitive psychology, language, and neuroscience on current teaching practices and offers a change in paradigm for the acquisition of literacy processes. The historical background also provides context for the origins of tenets within the current paradigm influencing elementary classroom instruction in the literacy processes. Learning, language structure/function, and language acquisition will be discussed through the lens of neuroeducation; the overlap of cognitive psychology, neuroscience, and language theory. The relationship between the acquisition of literacy processes and language function will be discussed in order to develop an explanation for making a connection between language and literacy.
Finally, the research will be synthesized in order to suggest a paradigm shift, representing a change in thinking about the acquisition of literacy processes generated from the triangulation of past instructional practices, language theory, and current neuroscience learning evidence. This paradigm shift will lay the foundation for future recommendations of neuroeducation based learning practices. Overall, the purpose of the study is to propose a neuroeducation approach for the acquisition of literacy processes (reading, writing, thinking, speaking, viewing, listening, and calculating) in the elementary (kindergarten through fifth grade) classroom.

**Historical Context of Literacy Instructional Practices in the United States**

Before a discussion of current practices in literacy acquisition in the school setting, it is helpful to understand how the events of the past influence the present as this research addresses the question: *What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?*

There has been debate since before the inception of this country over who should be educated, where they should be educated, why they should be educated, who should be doing the educating, and how the education should be delivered and even what was an educated person (Mathews, 1966; Smith, 2002). Throughout the history of the United States, most formal education focused on reading, writing, and mathematics, but also on the ability to listen, speak, view, and think. All of these literacy processes were of value as an educated person because these were believed to
be the fundamentals needed to access deeper understanding of larger historical, literary and democratic ideals as well as express an understanding of those ideals through the democratic process (Edgar, 2012; Leavell, 1943; Provenzo Jr, 2008). For this reason, when the term literacy is used within this study, literacy will be defined as the language functions and structures of reading, writing, thinking, listening, speaking, viewing, and calculating (Cooper, 2006). Although all learning is a form of education, for the purposes of this research, education is defined as learning that occurs in a formal setting with some form of instruction or contact with a teacher. This section of the review of literature will provide context for currently utilized literacy instructional methodology by examining the theoretical influences that were key in the development and use of literacy practices in the kindergarten through fifth grade, or elementary level, classrooms of today. The influence of cognitive psychology, language theory, and neuroscience of the current culture of instruction in the literacy processes will be examined so that the reader will understand how these fields developed and informed literacy instruction at the elementary level.

1700-1950: Access to literacy…For Some

This portion of the historical context of literacy instruction in the United States will focus on who was taught to read and write, why they were taught, and how they were taught in order to provide context for current literacy practices. The history of literacy and learning in the United States is vast and varied, so this section will confine the review of literature to the information needed to perceive the overall purpose and procedures in historical evidence for acquisition of literacy processes.
Historians (Edgar, 2012; Mathews, 1966; Smith 1962) agree that the earliest settlers of this country were focused on *what* a child learned far more than *how* they learned because of the importance given to religious text and understanding of doctrine. However, within the context of religious text, much emphasis was on the alphabet, and learning the alphabet in order to read words. Still, few common people were expected to read, write or calculate; there were no realistic expectations for a large segment of the population to be literate. Given the realities of the time period where the average person was engaged in manual labor most of the person’s life, only a small segment of the population was free from the backbreaking work of maintaining the basics of life.

By the early nineteenth century, literacy processes were a vehicle for the doctrine of democracy and the responsibilities of citizenship. At this time, historians suggest that the only constancy of educational institutions was the inconstancy of educational institutions (Edgar, 2012; Smith, 2002). While some more established states, such as New York and Massachusetts, during 1800-1850, had some semblance of an educational system (Provenzo Jr, 2008; Rickard, 1947), even more of the country was involved in settling the western frontier. Within unincorporated sections of the frontier, there was still no consistent organization of schools, or pressing need for formal education. Literacy was not a given right for all for during the first two centuries of the United States. Many peoples of the United States were deemed unworthy of a formal education in society that was highly stratified by social position and monetary resources. However, it was very possible for an individual to make a
living, raise a family, and contribute to society with minimal literacy in the form of writing, reading, and mathematics. When compared to life today, a relatively low level of overall literacy was needed for the everyday life of the average person one hundred and fifty years ago (Provenzo Jr, 2008; Zwiers, O’Hara, & Pritchard, 2013).

During the twentieth century, the general view of literacy and its importance for all citizens again shifted. This began with a large influx of new immigrants flooding urban centers and in general, more urbanization of the country, partially precipitated by the Great Depression and the decimation of many family farms during the Dust Bowl, which drove more people to large cities. In order to find meaningful employment in most cities, basic literacy skills were needed, so public schools began an attempt towards universal, free, public education (Mathews, 1966; Provenzo Jr, 2008; Smith, 2002). In addition, two world wars exposed a weakness in the national education system. When over 1.5 million new recruits entered boot camp during WWI, they were given a reading aptitude test. The results determined that 25% of adults could not read well enough to follow simple written instructions (Dutro & Collins, 2011; Edgar, 2012; Mathews, 1966). When similar results occurred during WWII, some politicians and educators began to question the effectiveness of the educational system and teaching methods of the time. Although the demands of the war distracted scholars from pursuing this question, the groundwork was laid for a reexamining of educational practices in postmodern United States.

Free education was available to most during the first half of the 19th century, but children of color were often provided substandard educational opportunities, and
children with any kind of physical or mental disabilities were not educated in a public setting, rather relegated to mental institutions (Lenneberg, 1970; Provenzo Jr, 2008). As in previous generations, although education was valued by citizens, if a child was unable to acquire literacy processes such as reading, writing, and calculating at school, there was still a place for that person within the home and family structure. This was possible because there were many jobs involving manual labor, which did not require advanced reading or writing in order to maintain an acceptable standard of living at the time. With so many more children enrolled in school during this time, there was more evidence, in the form of aptitude tests, of children who were struggling with the acquisition of literacy processes in the school setting (Dutro & Collins, 2011; Evers, Walberg, & Hoover Institution on War, 2002; Ryan, 2011). This led to educators asking more questions about common instructional practices in schools as well as possible differences among students.

The historical literature regarding the instruction of literacy processes points to one commonality across time and distance. Even though who has been taught and what they have been taught and why they have been taught may have changed, the basic instructional methods for literacy (reading, writing, thinking, speaking, viewing, listening, calculating) have not altered significantly during the past 150 years. The next section regarding the historical context of literacy acquisition in schools will examine the influences leading to a change in the nature of public education in the United States, which occurred after Brown vs. The Board of Education in 1951. With the legal acknowledgement of a flawed separate but equal system of education, the
public education system began the first steps to provide an equal opportunity for learning to all. As the enormity of the task of educating all children became a reality; linguists, language theorists, and eventually neuroscientists began to inform the development of classroom literacy instructional methodology.

**1950-Present: Access to Literacy…For All**

Today there exists the legal and ethical responsibility to educate all children, and the first time in this nation’s history where free and public education has been charged with such a task (Rebell, 2012; Rioux & Pinto, 2010). This shift to an equal opportunity for all learners to be literate began in postmodern America, starting with Brown vs. the Board of Education (1951) and culminating with the Education for All Handicapped Children Act (1975). For the first time in the history of the United States, all children, regardless of their race, language, physical or learning difference, were and still are, expected to be educated to their highest capacity within the public school setting. This shift occurred at a time when more children with special needs were, with advances in medical technology, surviving childhood trauma and disease. This meant that by 1975, there were more children with possible learning differences in need of education than at any other time in history; and, all of these learners were entitled to equal access to education (McLaughlin, 1995; Rebell, 2012; Rioux & Pinto, 2010).

Since the early 1950’s, there have been shifts in the theoretical lenses used to evaluate and influence the development of literacy materials and instructional practices. Three theoretical lenses; cognitive psychology, language theory, and
neuroscience, will be examined for their influence on teaching practices in classrooms during the fifty years before No Child Left Behind (Bush, 2001) legislation was enacted. The examination of the influence of the three lenses is suggested to provide a framework for identification of the relative influence of each theoretical lens on the development of literacy practices in relationship to NCLB.

**Cognitive Psychology**

This section will examine the influence of behaviorism and linguistic lenses on the formation of educational curricula in the United States during the later half of the 20th century. Cognitive psychology was in its relative infancy during this period, but the foundations of the theoretical basis of this field were being developed.

In an attempt to standardize an equal education for all students, curricula were created to help all children have the chance to learn, with the goal being that whichever teacher was in front of a child, each child would have equal access to acquiring literacy processes (Edgar, 2012; McLaughlin, 1995; Venezky, 1986). The commonly held belief, in the 1950’s, was that given a certain stimulus, an outside force could control and predict an action or reaction in a person. Behaviorism (Skinner, 1953) seemed to be the logical theory for the equal delivery of instruction to all children; if many different teachers gave all children the same input, then they could expect the same output. With this theory, any teacher could follow a written lesson plan sequence and the same learning would occur in any classroom. To provide each child with the same input at the same age and grade meant breaking down the desired products such as reading.
Breaking down a complex product, such as reading, into smaller, teachable parts is known as task analysis. An example of task analysis influence on instructional practices was its use to provide the sequence of lessons needed to build the complex process of reading (Chall, 1999b; Good, Kaminski, Smith, Laimon, & Dill, 2003; Heilman, 1964). In order to simplify the reading acquisition process, linguists were involved in breaking down the English language into smaller parts, in the form of individual sounds, in order to teach the parts to be built back up to read those parts as words. Another perspective on this phenomenon is the concept of the reductionist model, which has also influenced lesson design and instruction. An adult learner (teacher or curriculum author) would break a larger concept into small, component parts, then teach the parts in order to recreate the larger concept (Foster, 2013; McLeod, 2008; Newkirk, 2009; Poplin, 1988).

With task analysis and a reductionist model influencing curriculum design, small units of English language in the form of sounds, along with grammar rules, were sequenced and packaged into lessons for teachers. For the first time, phonics (Heilman, 1964), instruction in reading through the description of the phonetics of a language, became a widespread, required model for teaching reading and writing. In addition, the teaching of literacy through strong phonetic instruction was beginning at a younger age.

Before the 1950’s, the practice of teaching sounds and letters to children was usually reserved until third or fourth grade, after a child had much exposure to print and much language experience. After the 1950’s, this practice began in first grade, and
when kindergarten became more widespread, learning letters and sounds began even younger (Mathews, 1966; McLaughlin, 1995; Smith, 1962). Task analysis was also applied to mathematics as larger concepts were broken down into their component parts, then taught as a sequences of lessons by teachers (Foster, 2013; Poplin, 1988). Such task analysis also resulted in across grade level scope and sequence for content instruction.

The Elementary and Secondary Education Act of 1965, also influenced the instruction of literacy processes because the Federal Government was giving money to states to help give more disadvantaged children extra help in school (Edgar, 2012; McLaughlin, 1995; Rebell, 2012; Smith, 1962). There was new pressure placed upon schools to produce results on standardized tests since now school districts were accountable to the federal government. Accountability measures were realized in standardized tests, which aligned with a model of teaching and learning skills designed by the use of task analysis because individually taught skills could be isolated and measured. These accountability measures revealed that many children were struggling to acquire literacy processes within the framework of a heavily structured and skill based literacy paradigm (Bond & Dykstra, 1967; Goodman, 1972; Hayes & Nemeth, 1965; Smith & Goodman, 1971).

During the 1960’s and 1970’s, there was a movement away from behaviorism as a driving theory in education as more constructivism and social learning theories emerged which began to explain the ineffectiveness of operant conditioning (behaviorism) on children (Carroll, 1964; Clark, 1977; Halliday, 1977; Smith &
Goodman, 1971; Smith, 1962). This lead to an educational movement to design a more child centered school experience, reflecting the theoretical framework of the use and acquisition of language in young children. Language theorists investigated the acquisition of language in an attempt to understand how children learned to be literate outside the paradigm of behaviorism.

**Language Theory**

There were many seminal studies and theories explored and written about during the 1960’s, through the early 1980’s, regarding the importance of language acquisition through social interaction with implications toward the effects of language acquisition on literacy acquisition (Carroll, 1964; Clark, 1977; Dore, 1975; Fillmore, 1968; Halliday, 1977; Hymes, 1964; Searle, 1970; Vygotsky, 1962). The translation of Vygotsky (1962) clarified the connection between concept formation and language acquisition through social interaction. Other studies followed providing ample evidence of the importance of language acquisition and function and the relationship of language to the process of learning (Arwood, 1983; Bernstein, 1964; Hart, 1995; Holdaway, 1979; Kasten & Clarke, 1989; Krashen, 1989; Manning, 1989; Ratner & Bruner, 1978; Ribowsky, 1985; Slobin, 1991; Smith & Goodman, 1971).

At the time, the translation of the importance of language to learning in the classroom was demonstrated through the application of psycholinguistics to instruction called *whole language*. Similar to the methods outline by Dewey (1910), the learner would acquire the processes of literacy through the use of natural language within social interactions in the classroom (Brooks & Brooks, 2005; Kasten & Clarke,
While there was some evidence (Kasten & Clarke, 1989; Krashen, 1989; Manning, 1989; Ribowsky, 1985) of successful acquisition of literacy processes within a *whole language* model, some learners still found difficulty acquiring literacy processes. The inability of learners to acquire literacy even within an environment of language experiences may be attributed to a missing piece of the triangulation of theory provided by the addition research from neuroscience to create the neuroeducation model used in this study. The next section will provide context for emergence of neuroscientists and biologists proposing and then discovering empirical evidence between language, learning, and the neural activity in the brain.

**Neuroscience**

Lenneberg (1962) was a pioneer in the formation of a theory supporting a biological basis to language function first evidenced by language impairment in soldiers with brain injuries. This confirmed the existence of Wernike’s and Broca’s areas in the brain (Baars, 2010), established a century earlier. These areas had long been attributed as the main language processing centers of the brain. Lenneberg (1967, 1969, 1973) further suggested that language acquisition was dependent upon the function of the brain through evidence of children with brain abnormalities or restricted social interaction not acquiring the function of language.

Later, Damasio (1982) and other neuroscientists published some of the first brain scans of patients with observable damage to language centers, providing empirical evidence to the work of Lenneberg. Thompson (1986) provided evidence
that revealed a connection between the structures of the brain involved in learning and their relationship to memory. Merzenich et al. (1996), with a team of researchers, continued to provide neurobiological evidence for the link between literacy processes and neurobiology as they found differences in neural activity in the temporal lobe in learners struggling to read. Mohr, Pulvermüller, Mittelstädt, and Rayman (1996) found evidence of learning occurring across hemispheres in the brain, suggesting that learning uses the whole brain. The neuroscientists and their findings mentioned in this section are only a small representation of the information discovered during the past thirty years demonstrating the undeniable connection between the structures and function of the brain with learning and language use and acquisition.

A paradigm shift reflecting the neuroeducation theoretical framework asks the researcher to consider the overlap of cognitive psychology, language, and neuroscience as a translational approach when analyzing theory and empirical data regarding learning. Historically, there has been no overlap of these three lenses when considering instruction methodology involving the instruction of literacy processes in the elementary classroom setting. The purpose of this section was to provide an overview of literacy instructional practices with an emphasis on emergence of the three lenses of neuroeducation in order to provide a framework for the evaluation of current literacy practices and how they evolved. The next section provides the reader with a description of tenets influencing instruction practices within the current operational paradigm regarding teaching and learning. Previous description of the three lenses of neuroeducation was provided to assist in understanding the
philosophical underpinnings of the current operational paradigm so the instructional practices described in the next section have context within the neuroeducation framework.

**The Dominant Paradigm: Teaching and Learning**

This section will provide a background for tenets within the dominant operational paradigm currently influencing instructional practices found in elementary schools. The historical context of literacy instruction was provided in order to better understand the philosophical underpinnings influencing curricula design and implementation present in schools. It could be asserted that the cultural assumptions (Park & Huang, 2010; Sapir, 1949) assigned to the acquisition of literacy processes influence decisions made regarding how and when reading and writing will be taught. These assumptions are intertwined with assumptions made about how a learner acquires information. The delineation of the overlapping lenses of neuroeducation provide a framework for beginning to identify assumptions and biases inherent in the current paradigm influencing the culture of teaching and learning. The next section will examine multiple tenets within the dominant paradigm to clearly identify the lenses influencing current instructional practices for literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating); so, there is a clear description of these tenets in the context of this research. A clear description of current tenets and their influence on instructional practices will allow for an analysis of said practices utilizing the lens of neuroeducation in order to determine if there are tenets
within an operational paradigm that better align with the overlap of cognitive psychology, language, and neuroscience.

**Tenets Influencing Current Instructional Practices**

This section will include a description of tenets within the current paradigm influencing teaching and learning at the elementary level. In order to fully understanding how the current paradigm influences instruction, common cultural assumptions about learning must be identified. Within cultural frameworks, certain beliefs are so common and have such strong consensus that they are no longer questioned (Ashkanasy, Wilderom, & Peterson, 2000). Until they are explicitly delineated and explained, the underlying theoretical frameworks and their influence on teaching and learning of these dominant cultural beliefs may not be clearly understood. While there are many commonly accepted tenets influencing teaching and learning, this research will discuss five that often influence curricula and methodological decisions regarding instruction of the literacy processes (reading, writing, thinking, viewing, listening, speaking, calculating). Through the discussion of tenets within the current paradigm, it is important to refer to the current achievement of proficiency as measured by the National Assessment of Education Progress (NAEP). The NAEP shows evidence of only 40% (National Center for Education Statistics & Hager Sharp, 2013) of students nation-wide currently meeting proficiency standards in math and reading when learning within the current dominant paradigm, suggesting that the current paradigm might not be meeting the learning needs of many learners. In contrast, this study provides evidence in Chapter Four of 90% or more
students in a neuroeducation learning environment achieving grade level proficiency in reading.

Most curricula are designed with the common assumption that learning is taught by an adult giving students small, discrete parts of a larger concept in a predetermined order. In order to teach the discrete skills needed for current common academic standards, curricula have been designed with a predetermined order of systematic instruction (Arwood, 2011; Dutro & Collins, 2011; Foster, 2013; Goffreda & Clyde Diperna, 2010; Holdaway, 1979; Kozol, 2005b; Murnane, Sawhill, & Snow, 2012; Owens, 2010). For example, the literacy process of reading is often divided into discrete, separated language structures, which are systematically taught in the predetermined order, with the assumption that reading is the sum of understanding how discrete phonemes and morphemes fit together (Gardner, Cihon, Morrison, & Paul, 2013; Krashen, 2002; Missett & Foster, 2015).

The expectation that the adult predetermined order of instruction will allow the student to learn a whole concept formed by the understanding of the discrete parts will be referred to as a reductionist model of teaching (Foster, 2013; McLeod, 2008; Newkirk, 2009). The reductionist model appears to be widely accepted instructional practice evident in all areas of literacy processes, commonly represented by scope and sequence in lesson planning; an accepted and expected instructional model in most published curricula (Al Otaiba, Kosanovich-Grek, Torgesen, Hassler, & Wahl, 2005; Chall & Snow, 1988; Foster, 2013; Greenlee & Bruner, 2001; Newkirk, 2009).

The reductionist model has its beginnings in the breakdown of individual
behavior through task analysis, designed by Skinner (1953) to change unwanted behaviors. Such change was the result of programming through a process of rewards and reinforcement by the teacher (Estes, 1967). When the teacher gives information in a predetermined order, then expects the same information given back in the same form as evidence of learning, this will be referred to as an input (teacher gives) output (student give back to same) model of teaching.

Underlying any predetermined instructional sequence with prescribed instructional methodologies is an assumption that the information presented on a given day by a teacher will be received and understood by the student in the manner presented by the teacher (Al Otaiba et al., 2005; MacGillivray, Ardell, Curwen, & Palma, 2004; Missett & Foster, 2015; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). This is evident with the assumption that the instruction by the teacher (input) will result learning when the student can reiterate (observable output) the information given by the teacher. For example, if a student can correctly complete a teacher designed worksheet aligned to a teacher presented lesson, the student would be determined to have learned the material. The input-output model represents an understanding of learning outcomes based upon instruction designed for students to repeat the information given by the teacher. Training students in certain skills and measuring their learning from products that show evidence of replication of teacher output reflects a behaviorism (Estes, 1967; Skinner, 1953) based system of learning as stimulus/response.

Current instructional practices in the classroom emphasize observable
products; for example, completed end of chapter questions, worksheets, standardized assessments (Kozol, 2005b; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). The products completed by children are often in the form of repeated patterns, or surface structure repetition of direct content instruction by the teacher. Many of the classroom instructional practices place a heavy emphasis on the role of teacher as the giver of all information and the final judge of the quality of learning evidenced by the student (Al Otaiba et al., 2005; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). Much time, and professional development, is spent on teacher created lesson plans, daily goals, objectives, and outcomes. Student activities are based upon teacher plans and objectives, often requiring children to imitate the teacher model to receive credit for completion. The products become the evidence of learning, although the products are often a direct copy of the teacher-designed expected outcome.

There is an expectation within the current paradigm of teaching of a certain amount of instructional minutes involved in the fulfillment of curricular demands. Predetermine amounts of time spent engaging only in the predetermined sequence and prescribed methods of teaching (Chall, 1999a; Gamse & National Center for Education Evaluation and Regional, 2008; Gilbert et al., 2013; Owens, 2010) are assumed to ensure student learning as evidenced by measurable products. Prescribed time-periods of instruction for repetition and reinforcement of teacher prescribed information, in order for students to generate acceptable products, could be interpreted as a model of pedagogy based upon behaviorism (Skinner, 1953) first introduced in
the 1950’s to standardize the delivery and access of instruction. When students generate teacher-designed products, the assumption is that the information is learned. While generating *products* in the classroom, some students exhibit certain behaviors could indicate a learning difficulty with the current teaching paradigm. Assumptions regarding perception, learning, attention, and memory based upon observable behaviors are grounded in the theoretical framework known as Theory of Mind (ToM) (Baron-Cohen, 1997; Wellman, 2014).

The current educational system utilizes beliefs from cognitive psychology (Anderson, 2010) in regards to attention, memory, listening, emotions, intentions, beliefs, desires, perceptions and the acquisition of knowledge for designing pedagogy. The current educational setting uses observable behaviors to make assumptions about the mindset, attention and learning of students. Such assumptions about attitude and learning are also known as *Theory of Mind* (Baron-Cohen, 1997; Reisberg, 2013; Wellman, 2014), by which the outside observer determines the mental state of a subject by observing the subject’s actions, then assigning meaning to those actions. For example, if a student is not completing a task in class or attending to the oral information given by a teacher, they could be described as *distracted*, or *not paying attention*. The mental states of students involving perception, attention, listening, and memory are often evaluated by teachers who make assumptions about learning based upon the teacher’s interpretations of observable behavior. Many current studies seek to quantify the impact of attention (Koelewijn, Bronkhorst, & Theeuwes, 2010; Sloutsky, Deng, Fisher, & Kloos, 2015; Talsma, Senkowski, Soto-Faraco, & Woldorff, 2010),
confidence (Rinne & Mazzocco, 2014), self-regulation (de Bruin & van Gog, 2012), preference (Lucas et al., 2014) and effort (Finn et al., 2014) on the student’s ability to learn. These studies base their findings heavily upon the interpretations of observable behavior, reflecting a dominant way of thinking about learning.

When a student exhibits difficulty within the formal school setting, whether through a lack of production or a difference in observable behavior, attention is given to what the student cannot accomplish in an effort to remediate lacking skills (Harry & Klingner, 2007; Tangen & Spooner-Lane, 2008; Wragg, 2013), known as a deficit model. Research studies describe two manifestations of the deficit model in education. First, the deficit model places any learning difficulty evident in the school setting as a deficit in the child and something that must be fixed or remediated (Fedoruk, 1989; Harry & Klingner, 2007; Metsala, Stanovich, & Brown, 1998; Wragg, 2013). Second, the deficit model considers the weakness, or deficit, of the student in need of fixing through a remediation model stressing more instructional time spent on the deficit skill (Gilbert et al., 2013; Goss & Brown-Chidsey, 2012; Kozol, 2005b; Tangen & Spooner-Lane, 2008). The origin of the educational deficit model could be found within Western Psychology’s emphasis on statistical norms for learning and development. When a child does not fall within the definition of normal or typical, a deficit is found and then labeled (Campbell, 2011; Getahun et al., 2013; Miller, 2011; Peterson & Pennington, 2012; Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014; Pugh et al., 2000; Shankweiler et al., 1995) as the first step toward deficit remediation within the educational setting.
The current paradigm surrounding teaching and learning consists of commonly held beliefs, or tenets. The tenets are deeply ingrained into the culture of education and have a direct influence on beliefs regarding teaching and learning. Upon examination, most of the current tenets regarding learning theoretically originate from behaviorism, cognitive psychology, or Western Psychology. Within this framework, it is possible for many learners to have difficulty learning as evidenced by a steady increase in diagnostic labels over the past decade and low achievement levels on the NAEP. It is possible that the current paradigm regarding teaching and the process of learning does not provide the deep understanding of the learning process due to the narrow representative theoretical frameworks underlying accepted tenets. However, when the process of learning is examined using the lens of neuroeducation, a deeper description can be developed. The overlap of cognitive psychology (mind), neuroscience (brain) and the influence of language function will be used in the following section to fully develop a working definition of learning.

**What is Learning?**

There are many perspectives about the definition of learning from the philosophical (Peirce, 1972) to biological (Pulvermüller, 2003) to educational (illeris, 2009). This section will describe the construct of *learning* from cognitive psychology, neuroscience, and language perspective in order to triangulate a definition of learning from a neuroeducation lens. A neuroeducation definition of learning allows this research to address the following question: *What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating)*
can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?

Learning – A Neuroscience View

Neuroscientists describe learning as a permanent change at the neuron or cellular brain (Baars, 2010; Damasio & Geschwind, 1984; Pulvermüller, 2005). As a single neuron fires due to a change in the electrical (chemical) gradient of the cell, the cell chemistry seeks out neural circuits to propagate the chemical change. Such overlapping changes in the cells form circuits of connections, which ultimately integrate into larger networks of connectivity. Neurons await sensory information in what is known as an action potential, a state in which the neuron is primed to fire, to release neurotransmitters to another neuron, thereby strengthening connections (Baars, 2010; Gallistel & Matzel, 2013). If received stimulus is meaningful, or at the level of the cellular potential, the neuron potentiates, or fires, resulting in a change in the next cell and so forth. This process creates a cascade of effects known as brain activity. There is no partial firing of a neuron because either it remains waiting for information, or it is firing to send more information on to other neurons downstream, creating pathways. This neurobiological process requires new changes in the cells or information to activate the action potential of the 86 +/- billion brain neurons.

Likewise, there is evidence that repeated similar input does not increase or even create a change in the cells resulting neuronal action potential propagation (Bookheimer, 2002; Grill-Spector, Henson, & Martin, 2006; Macnamara, Hambrick,
This lack of change to old, repeated stimuli strongly suggests that on a neurobiological level, when it comes to learning, practice (the repetition of the same sensory-perceptual patterns) does not improve brain function (Bookheimer, 2002). In fact, such “practice does not make perfect.” It would be logical to assume that if practice (exact repetition of sensory-perceptual patterns) disengages brain activity (Bookheimer, 2002), then acquiring input through multiple, varied experiences would more likely engage the brain through the stimulation of action potentials.

As the neural pathways strengthen with repeated meaningful (meaningful refers to whether or not the action potentiation occurs) stimulation, they begin to wire together to form circuits of recognized information. The strengthening of neurons within the neural circuits is often described by the Hebbian Principle; neurons that fire together, wire together (Baars, 2010; Gallistel & Matzel, 2013). Neuroscientists have observed circuits of neurons that have wired together, which then layer to form networks, or webs, or neurons (Damasio & Geschwind, 1984; Göetzmann & Schwegler, 2010; Pulvermuller, 2013a). These neural networks are observable as signals of electrical activity during problem solving (language based) tasks on Functional Magnetic Resonance Imaging (fMRI) scans (Bookheimer, 2002; Pulvermüller, 2003).

It could be asserted that when there is a permanent change in neural circuitry, which allows the learner to access higher-level brain functions, such as problem solving, higher order learning has occurred. It is important to note that within the
brain, there are infinite possibilities of this wiring because each person has a unique perception of sensory input (Doidge, 2007; Gage & Muotri, 2012; Pugh et al., 2000). Therefore, while there are identifiable structures of the brain, the function of the cortical networks is widespread and the use of the different networks is unique to the person, indicating that there are multiple ways to acquire and use information stored in neural networks. This also suggests that the educational environment that allows for each child to use his or her own learning system to acquire higher order concepts results in better brain activity than a classroom based on drill or repetition of past patterns.

Learning – A Cognitive Psychology View

Cognitive psychologists describe learning as the response of a person to their environment, which results in a behavioral change (Estes, 1967). This older definition comes from the beliefs of behaviorism (Skinner, 1953) which include: the belief that all behavior is learned through association and habituation as response to stimuli, discrete stimuli evoke responses which can be strengthened through practice, and learning is evidenced by the observable output of products as responses to specific input by the programmer. Cognitive psychology also describes learning as accessing memories, acquired by habituated learning through practice, and transferring, generalizing, and applying the information from those memories into new situations (Anderson, 2010; Craik, 2002; Thompson, 1986). There may be limitations to describing learning solely through the lenses of behaviorism or cognitive psychology because if learning is only the sum of direct input and response to the environment,
then there is little explanation of creativity, artistic expression, and the creation of new ideas through connecting multiple concepts.

**Learning – A Language Theory View**

Language theorists would describe learning as the ability to *mean* (Halliday, 1977), to express an understanding of a concept in a way that others can understand. Learning is inherently social in nature, as the child only learns through meaningful interaction with another person, so it is possible to suggest that learning is inherently social in nature (Carroll, 1964; Chapman, 2000; Frith, 2007; Hymes, 1964; Lucas, 1977; Sapir, 1949; Whorf, 1944). Language is the means by which a learner expresses the concepts they have acquired, therefore, language is both the tool by which a child learns and the expression of what they have learned (Bruner, 1975; Searle, 1970; Vygotsky, 1962). Even pre-lingual infants show learning as they hold up their head, reach for objects, or sit up on their own. They have acquired enough neurobiological patterns through their interactions with their environment to use the muscles needed for those motor acts; but, their interactions with the environment are shaped through social interactions with adults and conveyed by language. Halliday (1977) writes that, “…in the course of learning language a child is also, all the time, learning *through* language…” (p.81), which succinctly describes the synergy between learning and language.

This synergy, between learning and language, is possible because as language is used, it is learned, and learning is responsible for the permanent formation of the structures of the brain that promote the use of language, such as the networks of neural
circuits (Kiefer & Pulvermüller, 2012; Pulvermüller, 2010, 2013a). Only through the use of language are the neural circuits and networks formed then pruned into efficient pathways, or grey matter, in the brain (Arwood, 2011; Pulvermüller, 2003; Pulvermüller, 2005). When neural connections are made, there is learning, yet there is only learning through the social interaction of using language to name the stimulus received by the sensory receptors (Damasio & Geschwind, 1984; Lenneberg, 1973; Pulvermüller, 2003).

An overarching theme for the definition of learning, which crosses all disciplines, is that learning manifests itself in some kind of permanent change, either by externally observable products or at the neurological level (Anderson, 2010; Baars, 2010; Vygotsky, 1962). This permanent change means that whatever has been learned is now a part of the learner and can be used productively in many different ways as needed by the learner (Arwood, 1983).

As previously discussed, there is a strong connection between the use of language and activation of the neurobiological processes representing learning and the cellular level. Since there is a connection between the use of language and the biology of the brain (Damasio & Geschwind, 1984; Lenneberg, 1967, 1969; Pulvermüller, 2003; Pulvermüller, Shtyrov, Ilmoniemi, & Marslen-Wilson, 2006; Seger & Miller, 2010), there may be a need to explore the characteristics of language in order to fully understand language. The next section will explore language through the lenses of cognitive psychology, neuroscience and language theory to develop a neuroeducation understanding of language.
Language

What is language? For this purpose of developing a neuroeducation description of language, language may be analyzed and described using the three lenses of neuroeducation: cognitive psychology, neuroscience, and language itself from the writing and study of language by philosophers, linguists, socio-linguists, and psycholinguists. The following section confines this study to English, although many of the features of language acquisition process described in this section can be used to describe multiple languages. In addition, it is important to know that the language acquisition process described in this section is not referring to second language acquisition, but as the process of acquiring a first language from a social interaction and neuroscience based theoretical model.

To begin this exploration of language, there will be a discussion on the structure and function of the English language in order to fully define the operational terms needed for this research. The operational terms, critical for the literature base of this research, are defined in this section will support the coding terms required to address the following research question: How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy?

English Language

All languages have a structure and purpose that is identifiable by linguists; the structure of language is found in its identifiable parts and the purpose of language is
found within the function of the parts to form a whole act of communication. This first half of this section will describe the structures of the English language that allow English to easily be broken down into its component pieces, allows English to adapt to new situations, and allows English to be described as a phonetic, sound based language. The second half of this discussion will describe the function of English, how deep semantic meaning is represented in the structure of the language, and the underlying semantic function of the temporal elements in the English language. Delineating the differences between the structure and function will be useful in fully describing the English language and its acquisition.

**Structure.** Structures of language can be described using rules (Arwood, 2002; Arwood, 2011; Chomsky, 1968; Clark, 1977) and these rules define the use for each structure within a language. The smallest structural units in English are sounds called phonemes, and the smallest units of meaning are morphemes. Once units are formed from the phonemes and morphemes, they are called words, known structurally as vocabulary. Then a language can be described by the order of the words called grammar, or syntax, which also includes different parts of speech, such as verb and noun. Finally, the overall meaning of the word order and vocabulary is known as semantics. The linguist identifies and records these structures of language, and can do this with little understanding of the use, or function, of the language by determining a regular repetition of patterns (Bruner, 1975; Carroll, 1964; Chomsky, 1968). It could be suggested that structural learning or analysis of a language only represents a surface
understanding of a language and therefore only describes the surface structure of language (Clark, 1977; Dore & McDermott, 1982).

Some structures of language are specific to English, such as the, at, to, a, called *functors* because they function to connect the meaning between the subject, verb, object agreements. English is referred to as an inflectional language; words are comprised of bound morphemes in the form of suffixes and prefixes, which can change the meaning of free morphemes, also known as root words. The English language has many free morphemes that are alphabetic in nature because they are comprised of sounds, which can be translated into graphemes, which represent individual spoken sounds. However, there have been linguistic shifts since the beginning of written English (Mathews, 1966; Smith, 2002), which have resulted in spoken graphemes no longer exactly corresponding to the written English language. Time based words are also a part of the structure of English, both vocabulary, such as *tomorrow*, *again*, and *next*; and within verbs through the bound morphemes, for example, *play* becomes *played* and *run* becomes *ran* to express past tense.

English is referred to as a low-context language because the words in the structure of the language do not require situational cues or context to convey meaning; there is an assumed shared meaning for each isolated word (Arwood, 1983; Carroll, 1964; Sapir, 1949). The structure of language allows for meaning to be conveyed without creating a visual context because the speaker uses oral words to represent ideas. Oral words, which have meaning in isolation, provide the English speaker with the structure to state, “I’m going to play now” without relating what came before, or
how the play will look, or where they are going to play. Another example might be “Now it is time to go,” which give the listener limited context or meaning from the words only: Any context must be derived from the individual words and unspoken cues around the listener. There are no contextual clues within the utterance itself, and yet such instructions and statements are quite common in the English language.

There is also a structure to the social use of language called pragmatics. Pragmatics is the predictive use of structure in social situations, such as saying “Hello, how are you today?” and replying “I am fine, thank you.” When a linguist can note these predictive functions of social interaction, they are referred to as pragmatics (Arwood, 2011; Hart, 1995; Lucas, 1980; Tomasello, 2004).

Linguists also describe the English language in terms of surface structure and deep structure. The deep structure of language is the basis for the surface forms of language. The deep structure is represented in the surface structure of language by the use of propositions within a sentence, which are formed from the implied, deeper meanings of underlying arguments (Arwood, 1983; Chomsky, 1968; Clark, 1977). For example, the sentence The black cat ran quickly across the sidewalk to catch a mouse involves multiple arguments, such as: there is a cat, the cat is black, the cat can run, the cat can run quickly, the cat can run across a sidewalk, there is a sidewalk, the cat wants the mouse. When these arguments are interconnected, the propositions, or new surface meanings, are created. In this case, the purpose of why the cat ran was to catch a mouse. Multiple propositions are implied through the surface forms. The surface form represents the meaning, or semantics of, the deep structure of the
thought. The spoken utterance is an imitation of surface sounds from speakers, while the surface meaning is a representation of deep constructs. However, a person who struggles with processing the sound of words cannot always see the connections between the surface forms and the underlying deep meanings, adding to the difficulty of the low-context nature of the English language for those who cannot understand the deep meaning. Language experts (Bruner, 1975; Clark, 1977; Halliday, 1977; Hymes, 1964; Vygotsky, 1962) agree that understanding the deep meaningful structures that result in propositional meaning of sentence structure is critical for understanding the functional use of English.

**Function.** The function of language is greater than the sum of its parts (Arwood, 1983; Dewey, 1910; Peirce, 1902) as demonstrated by the underlying deep structure of any sentence. Functional language is comprised of various semantic relationships based on situational, relational, and purposeful acts (Bruner, 1975; Hart, 1995; Ratner & Bruner, 1978; Searle, 1970; Wenger, 1998). Functional language is situational in that the use of language functions helps adapt the learner to different social situations and environments. For example, language function shifts to meet the situational needs of school, home, playground, store or other locations where certain functions of language would be acceptable, but not others. Language is relational because it functions differently for the different people in social settings. For example, language function can shift to accommodate speaking to a friend, a young child, a teacher, or a family member. The use of functional language as a relational tool assists in the acquisition of agency (Arwood, 1991; Halliday, 1977; Tomasello, 2004;
Vygotsky, 1962). Agency is the function of language to place oneself in relationship to others, and is a key component in the functional use of language; the ability to see another and how they relate to the individual (Arwood, 1991; Arwood, 2000; Chapman, 2000; Lucas, 1980; Wenger, 1998).

Language function, even from the first forms of communication, (Arwood, 2011; Halliday, 1977; Searle, 1970; Vygotsky, 1962) meets a purposeful need. In this way, the child or agent is able to accomplish acts and express wanted needs. Without the function of language, the individual is dependent upon others. These early, relational functions as agents, who do actions, to get needs met increase in depth over the lifespan. This depth results in creating several other important language functions needed for the speaker to engage in the formal use of language.

The acquisition of functional language for the child is dependent upon the adult assigning meaning to a child’s interaction with the child’s environment (Chapman, 2000; Halliday, 1977; Jones, 1995; Vygotsky, 1962). As the child acquires more functional language through social interaction, the child is able to understand places and objects that are displaced in space and time; that is, the child learns concepts that cannot be directly seen and touched. This function of language is referred to as *displacement*, which represents the acquisition of multiple layers of conceptual meanings removed from the concrete referent (Arwood, 2011; Brooks & Brooks, 2005; Carroll, 1964). As the learner is able to understand concepts, which are displaced in time and space, underlying semantic (meaning) relationships are also layering to connect multiple arguments that form cognitive propositions (Clark, 1977)
underlying the function of language. This meaningful overlap of multiple semantic relationships layered in concepts is referred to as semanticity, which is another way to describe the underlying meaning or deep structure of the language. The learner expresses underlying semanticity through flexibility and productivity (Arwood, 1991, 2011; Bruner, 1975; Halliday, 1977; Lucas, 1980; Sapir, 1949). The function of flexibility provides the learner multiple ways to think about relationships in order to cognitively manipulate or produce them in new ways. This is the function involved in decision-making and problem solving. Productivity is a function of language that allows the learner to utilize their language in a variety of ways, such as reading, writing, mathematics, speaking, art, or any other meaningful expression of language someone can design.

Understanding the function of language as different from the structure of language is important for this research because the acquisition of literacy processes will be identified as a process tied to the functional use of language in the learner. The next section will describe language from the three overlapping lenses of neuroscience, cognitive psychology, and language theory in order to develop a definition of language that aligns with the theoretical framework of neuroeducation.

**What is Language? - Neuroscience**

Researchers have been engaged in brain research to find the biological underpinnings of the formation or acquisition of language for several decades (Damasio & Geschwind, 1984; Lenneberg, 1973; Pulvermüller, 2003). From a biological perspective, language can be defined as the structures of the brain that
receive incoming sensory input, convert the input into recognizable perceptual patterns that are then sorted into meaningful information through various relay stations in the brain (Baars, 2010). Language represents the creation of strong neural pathways, which layer to form circuits of strong neural connections, which then connect with other circuits to create more layers of connections (Arwood, 2011; Pulvermüller, 2010; Pulvermüller, 2003; Seger & Miller, 2010). Pulvermüller (2013a), Bookheimer (2002), and Finn et al. (2014) have noted wide spread brain activity in fMRI scans when participants are involved in any language function task. Evidence of wide spread brain activity during language function tasks has led neuroscientists to postulate that the use of language is a highly integrated neural activity, requiring connectivity of cerebral cortex to the rest of the brain (Arsenault & Buchsbaum, 2015; Gallistel & Matzel, 2013; Geake, 2004). Such overall synergy of the brain for language suggests that language is more than just a set of imitated structures.

**What is Language? – Cognitive Psychology**

From the field of cognitive psychology, the definition of language is often discussed both in terms of language structures as defined by linguists and in specific brain structures described by neuroscientists. The cognitive psychologist acknowledges structures in the brain that have traditionally been accepted as part of the language processes. These are Broca’s area, which is attributed with determining the ability to use spoken language, and Wernicke’s area, which is attributed to determining the ability to understand spoken language (Anderson, 2010; Greene, 1985). Both of these discoveries were made due to behavioral changes occurring when
damage occurred in specific areas; attributing these behavioral changes to one specific portion of the brain. This one-to-one correspondence between behavior and structure describes a modular or structural view of the brain (Baars, 2010).

Linguists (Chomsky, 1968; Fillmore, 1968; Hymes, 1964) have influenced the definition of language in this area by describing structure of language, noting the amount of utterances and the regularity of utterances. The regularity of utterances refers to the basic structures of a language that are repetitive patterns, such as the subject-verb-object order in English sentences. Linguists define rules within the regularities of structure in any given language, with the rules for these structures defined by linguists heavily influencing the definition of language in the field of cognitive psychology (Anderson, 2010; Greene, 1985). Such rules describe the overall grammar (structure) of a language, which include the syntax (rules of the order and structure of a language), phonology of a language (the sound structure of a language) and the semantics of language (the meaningful use of units of meaning). The ability to produce these structures of language with regularity is the beginning of the definition of language in the field of cognitive psychology (Craik, 2002; Greene, 1985). Discussion of language in the field of cognitive psychology is based upon purely observable products of language, such as transcribed oral speech utterances. When the use of language is defined as observable utterances, this is representative of only the surface structure of language (Clark, 1977). Therefore, an overview of language theory will help broaden an operational definition of language by providing the conceptual underpinnings for the deep structure, or function of language.
What is Language? - Language Theory

During the late 19th century, Peirce (1878, 1902) in his philosophical writings, attempted to explain the nature of language as the relationship between a sign, symbol and human indicator represented by the qualitative attributes of firstness, secondness, and thirdness. Firstness represents an icon indicated by what can be seen, touched or felt by the individual. This sign has no meaning to another and requires interpretation from an outside source in order to assign meaning. Secondness exists when the meaning of the icon is shared between multiple agents. When multiple relationships between signs are learned through shared meaning, then thirdness, or symbols are created from the signs. Thirdness represents symbolic, formal language that can be communicated in multiple ways and interpreted by others. The symbolic language which is represented by spoken, written, drawn, or signed language can only exist when there is another human indicator to agree upon the meaning, therefore language only exist when constructed within social interactions (Bruner, 1975; Carroll, 1964; Dore & McDermott, 1982; Hymes, 1964). This use of social interaction through language to construct the underlying meaning of shared system of symbols is referred to as the semiosis of language, an infinite ability to produce meaning through the relationship of signs and symbols. Peirce recognized that the whole process of understanding and acquiring a language was greater than the observable structures or parts, so he referred to this synergy between deep functions and structures as pragmaticism (Arwood, 1983; Peirce, 1902).
Pierce’s description of language confirms and explains the observations of anthropologists (Hymes, 1964), psychologists (Bruner, 1975; Halliday, 1977), linguists (Carroll, 1964; Sapir, 1949), and psycholinguists (Clark, 1977; Goodman, 1972): language only exists when there are semiotic transactions of meaning between and among people. This overlap between the indicator/sign created and shared between agents forms layers of conceptual meaning, leading to the formation of the symbol (Arwood, 1983). Language has purpose and creates meaning between at least two people through the context of the shared experience, is referred to as deixis (Arwood, 1983, 2011; Dore, 1975; Searle, 1970). The next section will synthesize the previously discussed three lenses; neuroscience, cognitive psychology, and language theory to present a neuroeducation definition of language.

A Neuroeducation Operational Definition of Language

The neuroscience, language, and cognitive psychology descriptions of language will be overlapped to create an operational definition of language using the lens of neuroeducation. In the context of neuroeducation, this researcher will define language as sharing the meaning of a sign in a symbolic relationship with another person’s set of signs and symbols in order to achieve a purpose (Carroll, 1964; Dore & McDermott, 1982; Tomasello, 2004). Such symbolization is represented in the brain by strong neural networks of circuits, using efficient pathways to layer information in synergistic networks (Baars, 2010; Gallistel & Matzel, 2013; Göetzmann & Schwegler, 2010; Pulvermuller, 2013a). There exists a strong relationship between the outward structures use of oral language and the underlying meanings. The relationship
between the surface structures of language and the underlying deep semantic
structures of language occurs because via the neural structures, which occur through
meaningful overlapping pathways to form networks to create oral language (Damasio

Language is the outward representation of the neural acquisition of cognition,
or thinking; thinking is the mental representation of concepts (Arwood, 1991; Szücs &
Goswami, 2007; Vygotsky, 1962). Therefore, how a learner represents their mental
concepts, through their use of language, reflects their thinking (Carroll, 1964; Sapir,
1949; Whorf, 1944). It may be possible that there are many several different forms of
representational cognition, which reflect an individual’s unique neural network
connections. There is strong evidence in the literature pointing to cognition being
represented in unique ways for the individual learner, which matches with the
understanding that all sensory input that creates such meaning is unique to each
individual. The next section will present relevant information regarding the acquisition
of brain structures needed for language function with evidence suggesting that there
are multiple forms of cognition (thinking) represented by language. And,
concomitantly, there are a variety of surface forms representing the underlying
differences in thinking and neural uniqueness involved in language acquisition.

The previous section provided the research with an operational definition of
language, its structure and function, and how language represents cognition.
However, there has been no discussion on how language, which is an individual’s
representation of cognition, is acquired by a learner. The next section will provide
background on how the three lenses of neuroeducation define the language acquisition process in order to align the process of language acquisition with the process of learning for the purpose of future triangulation to inform possible instructional shifts.

**Language Acquisition**

This section of the review of literature will provide multiple theoretical lenses to explain the process of language acquisition. As described earlier in the review of literature, language represents cognition, or thinking, therefore language acquisition could be considered a critical component in the ability of the individual to acquire literacy processes. Access to language acquisition should be an important component of educational curricula, so an understanding of language acquisition by the educator is critical in order to provide learning opportunities for all children. This section also important in order to address the following research question: *What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks?*

**Language Acquisition – Cognitive Psychology**

The ability to produce oral speech using conventional grammar is described as developmental in the field of cognitive psychology; meaning that the ability to speak conventionally is a naturally unfolding process (Greene, 1985; Halliday, 1977; Piaget, 1959; Searle, 1970). For example, children use one-word utterances, then two word utterances, and then full sentences in stages as they develop natural language. Piaget
(1959) tied these developmental products to levels of understanding of concepts as a child moves from preoperational, to concrete, to finally a formal level of development, based upon the developmental age of the child. Chomsky (1968) described language acquisition as a developmental process that will occur in all people as they acquire the universal grammar (structures) of a language.

However, there are numerous examples of children who do not acquire language (Arwood, 1991; Jones, 1995; Lenneberg, 1970; Lucas, 1977; Miller, 2011; Shriberg, Aram, & Kwiatkowski, 1997), on scale of developmental language milestones. The lack of observable language use in some children is evidence that these children have not created the neural networks needed to create concrete level language concepts (Finn et al., 2014; Kiefer & Pulvermüller, 2012; Pulvermüller, 2003). When language is not acquired, evidence points to several factors, which are either neurobiological, such as a genetic differences (Hustad et al., 2014; Zampini & D'Odorico, 2013), physical trauma (Allen & Oliver, 1982; Augoustinos, 1987), or withholding of social interaction due to extreme cases of neglect or physical abuse (Eigsti & Cicchetti, 2004; Law & Conway, 1992; Lum, Powell, Timms, & Snow, 2015). If language were an innate human, developmental process, it would follow that circumstances would not alter the eventual development of language. However, there are multiple case studies (Augoustinos, 1987; Kavanaugh & Holler, 2014; Lum et al., 2015; Merritt & Klein, 2015) that describe little or no language development in children with genetic differences, or who have experienced severe emotional or physical trauma.
It is therefore reasonable to conclude that, by its definition, language acquisition is not an automatic, unfolding developmental product as described by cognitive psychology, but may instead be a product of a neurobiological, social interaction based acquisition process. The next section will describe the neurobiological basis for language acquisition in order to develop a neuroeducation definition of language acquisition.

**Language Acquisition - Neuroscience**

As the sensory input enters through human receptors (eyes, ears, hands) the brain begins to recognize patterns, which are neurons firing electrical signals that activate other neurons. When visual input is received at the sensory level by the eyes, it activates cones and rods, the photoreceptors, which distinguish photons, light energy, bouncing off the edges of surfaces (Baars, 2010). Eyes, as a sensory receptor, are capable of recognizing light input because that is their structural design, which determines their function. In the same way, ears only receive acoustic sound waves, which is the function of their structure. Only when sound waves or electromagnetic (light) waves are converted to electrical signals through the auditory nerve or optical nerve does the brain begin to convert the sensory input into perceptual patterns.

Neurobiologically, eyes do not see, and ears do not hear because they are input specific organs. Seeing and hearing represent organized perceptual patterns, which begin in the lower structures of the brain, also known as the midbrain. When a learner can use oral language to name what they can see and hear, this is a function of language (Lenneberg, 1962; Tomasello, 2004; Vygotsky, 1962), a process occurring at
the cortical level of the cerebrum. It may be an incorrect assumption that just because a person can physically collect photons (see) and acoustic elements (hear) that they understand and can make meaning from the signals received from outside the central nervous system (CNS).

Firing neurons that recognize sensory input as cellular patterns begin to connect into circuits of neurons, firing together and strengthening the connections between the synapses (Baars, 2010; Bookheimer, 2002; Grill-Spector et al., 2006). This structural increase of connections mirrors the increase in function of the learner’s neurobiological system. As the learner acquires patterns that form pathways, then circuits in the brain begin to create mental images that represent concepts. The layering in the brain continues as circuits begin to inhibit and integrate new signals, allowing the circuits to overlap and cross over to and through multiple relay stations in the mid-brain to form cortical networks of circuits. Networks of circuits represent language acquisition for the learner (Arwood, 2011; Gallistel & Matzel, 2013; Pulvermüller, 2005).

The connecting pathways through cortical networks result in dorsal and ventral streams that often activate the prefrontal cortex. The overall streaming through multiple connected neural networks creates the synergy of the brain for semantic, or long-term memory (Anderson, 2010; Baars, 2010; Gallistel & Matzel, 2013; Thompson, 1986).

The brain can integrate relevant information into the networks of neural circuits, or inhibit information from going to one network while sending it to another
network where the information can add another neural layer (Baars, 2010; Gallistel & Matzel, 2013; Göetzmann & Schwegler, 2010). This inhibition/integration of perceptual patterns into concepts represented by neural circuits is critical for the formation of language because such organization forms the neural networks, representing language (Pulvermüller, 2003). In other words, the functions help form the structures and the structures change in relationship to the functions. The unique structures in the human brain of a large cerebral cortex and well-developed frontal lobe as evidenced by fMRI scans during language-based tasks (Bookheimer, 2002; Pulvermüller, 2010; Tagamets, Novick, Chalmers, & Friedman, 2000) are unique, resulting in human acquisition of language, a very displaced, flexible, and productive system of underlying deep semantic functions.

However, there may be more to language acquisition than the potential of neural structures to accommodate the information received because language is not acquired without social interaction. In other words, the neural structures do not develop without the social input. In order to understand the importance of social interaction for the acquisition of language, the next section will provide background from multiple theories of language acquisition. These theories will be overlapped to provide evidence of synergy between the function of language acquisition and the acquisition of structures for language function as developed by the brain.

**Language Acquisition – Language Theory**

Language acquisition is the process of the formation of concepts (Lenneberg, 1962; Pulvermüller, 2012), which are biologically represented in the layers of
networks of neurons in the cerebral cortex (Arwood, 2011). Vygotsky (1962) explains that concept formation is complex and unique, representing a multitude of experiences gained through social experiences. Each word represents a multilayer concept learned through social interaction with peers and adults using language (Carroll, 1964; Halliday, 1977; Tomasello, 2004). Without this social interaction, no language would form and therefore, no concepts, which explains the lack of language acquisition in children with restricted social interaction (Lenneberg, 1969). Vygotsky (1962) observed that children must both use language to form concepts; and, that the use of language by children represents their understanding of concepts. He also found that concept formation takes place over many years, with a child reaching the point of abstract, or formal, thinking beginning in early adolescence. Until early adolescence, children rely heavily on interaction with an adult user of language to create meaning for concepts. He states that, “Verbal intercourse with adults thus becomes a powerful factor in the development of the child’s concepts…it is the rule rather than an exception in the intellectual development of the child” (p. 69). Current evidence from neuroscience validates Vygotsky’s theory of concept development requiring social interaction. Without an outside agent naming and refining concepts for the child (Arwood, 2011), sensory input cannot receive the meaning needed to integrate into the language networks in the brain (Lenneberg, 1962; Pulvermüller, 2012). When information is not meaningful, it remains at the pattern level in the brain. As patterns enter the brain, they are integrated or inhibited depending upon the meaning assigned to them and upon the neural pathways and complex layers where they will strengthen
a connection (Baars, 2010). If the perceptual patterns have no meaning, or cannot connect to existing neural circuits, they move through multiple relay stations, such as the hippocampus and thalamus, in the brain (Baars, 2010; Seger & Miller, 2010). Relay stations in the brain are subcortical, which means they move information; but, do not integrate information into neural networks. When perceptual patterns are not integrated into meaningful neural circuits they do not become concepts, therefore not creating long term potentiation (memory) and so are quickly forgotten.

Researchers (Krashen, 1989; Loeb, Gillam, Hoffman, Brandel, & Marquis, 2009; Smith, 1999) have found that children could be taught acoustic patterns and repeat them, but did not integrate them into their own natural language. This could be explained because language represents neural networks formed in the cerebral cortex, which confirms the neurological description of patterns not forming long-term memories. However, as concepts begin to layer and connect to other concepts through the use of language across multiple events, the circuits develop into neural networks representing systems of concepts that represent language (Arwood, 2011). Neural networks representing language are layers of neurons with the ability to inhibit and integrate new perceptual patterns to further strengthen neural circuits.

Neurobiologically, the brain requires function to create structure, and the function of language initially occurs as the interaction between the adult and child as adult language adds meaning to perceptual patterns. Dewey notes, “Learning, in the proper sense, is not learning things, but the meaning of things, and this process involves the use of signs…” (p.176). The ability of the adult to create and layer meaningful signs
(Peirce, 1878, 1902; Zeman, 1977) with the child is critical for the acquisition of language and the formation of brain structures. Without the structures, more language cannot be acquired; one is dependent upon the other. It is logical to suggest that since social interaction is required for language acquisition then the acquisition of neural structures can be directly tied to meaningful social interaction.

There appears to be a strong connection between learning, language acquisition and the neural structures and functions of the brain. In order to describe the overlap of these three phenomena and their impact on the learner, the next section will describe a theoretical lens for their integration. The Neurosemantic Language Learning Theory (NLLT) (Arwood, 2011) will allow the educator to address the needs of the learner through understanding the synergy between language and the brain and how they contribute to a neurobiological learning system.

**Neurosemantic Language Learning Theory**

There is a current theory of language acquisition acknowledges the critical role of language and neuroscience for the acquisition of language is the Neurosemantic Language Learning Theory (NLLT) (Arwood, 2011). This theory proposes that learners have sensory receptors (ears, eyes) that receive sensory information, which is converted to perceptual patterns in the brain. These patterns have no way to connect into strong neural pathways because they are just single neurons firing until an outside agent (human indicator) names those patterns with the use of language. When enough patterns are named and become meaningful to the learner, they begin to overlap into strong neural circuits, which form concepts. These concepts are the beginning of
thought, or cognition. When the neurobiological learning system, which is defined as “the central nervous system pathways that allow for incoming information to create tracks of learning for later recall and retrieval” (Arwood, 2011, p. 388) begins to overlap the conceptual circuits through meaningful language experiences with outside agents; the circuits form networks of neurons representing language function.

When multiple neural networks have been acquired, a learner can use his or her own language to represent cognition, or thinking, in multiple ways. They can speak, view, listen, acquire the understanding of reading, writing and calculating. Only when a learner has strong, interconnected neural networks can the learner access and use language. In this way, both the neurobiological learning system and the outside agent naming patterns with language will allow the learner to overlap enough patterns to form concepts, which can then be represented by the spoken word. The Neurosemantic Language Learning Theory (Arwood, 2011) combines theories of language acquisition (Halliday, 1977; Sapir, 1949; Tomasello, 2004; Vygotsky, 1962) with the neurobiological scientific knowledge available today regarding language acquisition and learning (Damasio & Geschwind, 1984; Pulvermüller, 2003). It is the only current theory of language acquisition and learning that connects the function of language to neural structures and functions of the brain.

**The Acquisition of Cognition**

As the layering of neural circuits occurs, the ability to think, which is the ability of a person to formulate ideas, emotions, and semantic, meaningful concepts (A. Damasio, 2003; Kiefer & Pulvermüller, 2012; Lenneberg, 1962; Szücs &
Goswami, 2007) is also occurring. As sensory information enters the central nervous system, there is an overlap of the sensory systems to form overlapping perceptual patterns from sensory input (Ghazanfar & Schroeder, 2006; Klemen & Chambers, 2012; Talsma et al., 2010). This is called cross-modal integration. For some individuals, this occurs with the integration of information from the auditory receptors and the visual receptors. Only humans are capable of this cross-modal perception. Current research (Stevenson et al., 2011) suggests that there is a function in the brain developed for the purpose of the integration of visual and acoustic patterns; this is called *temporal synchrony*. Temporal synchrony refers to the clear integration of acoustic with visual sensory patterns from the eyes to the ears through multiple integrations at the nuclei of the auditory pathways (Baars, 2010).

Learners who show evidence of temporal synchrony often describe their mentally represented concepts as auditory, represented by the sound of their own voice only. Learners with this learning system do not report clear visual pictures or visual graphics as conceptual images (Arwood, 2011; Arwood & Robb, 2008; Arwood, 2002). The brain receives sensory-perception input from multiple senses simultaneously, such as eyes and ears receiving input as a speaker talks. The brain integrates the sensory-perceptual input into existing neural networks as the input is recognized. As the brain begins to make meaning from the layering of neural networks to for language, this creates cognition, or thinking (Baars, 2010; Damasio, 2003; Damasio & Damasio, 2006; Gallese & Lakoff, 2005; Johnson, 2006; Moseley & Pulvermuller, 2014; Searle, 2000).
These concepts are not acoustic because an acoustic signal is not cross-modal and represents only pure sound with no overlap with another sensory receptor. This form of cognition matches closely with the properties of the English language described earlier – temporal, low context, displaced, and a learner with this cognition is able to connect sounds and visual stimuli simultaneously. This cognition is referred to as auditory cognition (Arwood, 1991, 2011).

Visual Cognition

There is another form of cross-modal integration, taking place at the sensory level, which involves an overlap of multiple visual inputs. For example, a person can see the movement of the mouth with the writing of words on a whiteboard, which gives the learner two visual sensory inputs which allow for cross-modal integration (Gage & Muotri, 2012; Koelewijn et al., 2010). Other learners will use the visual perception from the mouth while it moves to create a visual-motor overlap of cross-modal sensory information. Intra-modal integration within the visual system will also create visual circuits or images. The sounds entering the auditory nerve do not have temporal synchrony with the visual information received by the optic nerve (Arsenault & Buchsbaum, 2015; Stevenson et al., 2011; Zhang et al., 2011). The movement of the hands in space or the movement perceived by the eyes are also cross-modal in their function, and will create visual concepts (Gallese & Lakoff, 2005; Gross, Hayne, & Drury, 2009; Pulvermüller, 2005).

Current neuroscience research is finding evidence of lower activity in the temporal lobe during conceptual language tasks (de Abreu et al., 2014; Laszlo &
Sacchi, 2015; Miller, 2011; Odegard, Ring, Smith, Biggan, & Black, 2008),
supporting the theory that for many people, the temporal lobe is more of a relay station
for perceptual patterns than a location for semantic conceptual layering of neural
networks. In addition, brain scans utilizing fMRI have detected abnormalities in the
structures of the brain attributed to phonological processing (Arsenault & Buchsbaum,
2015; Moseley & Pulvermuller, 2014; Pulvermuller, 2013b; Stevenson et al., 2011;
Zhang et al., 2011). Qualitative research; such as interviews, questionnaires, and oral
language samples, have found evidence of children and adults who describe visual
of their learning system. For many of them, the neurobiological learning system,
which integrates the cross-modal sensory input to form perceptual patterns, does not
require the acoustic sensory input to create semantic neural networks.

The brain allows neural wiring to bypasses any integration of acoustic
information if that information is not meaningful. For example, visual neural pathways
are created which allow the formation of concepts from the information gained from
meaningful movement, such as American Sign Language, drawing, or writing, which
can integrate to form layers of circuits in the cerebral cortex to represent visual
concepts (D’Ausilio et al., 2009; Dekker, Mareschal, Johnson, & Sereno, 2014;
Franceschini et al., 2013; Sadato et al., 1996).

Recent research reaffirms the concept of neuroplasticity by demonstrating that
the brain structure can even change depending on the instructional methods used with
students (Bassett et al., 2011; Frith, 2007; Park & Huang, 2010). Visual cognition can
be represented as mental movies, pictures, shapes of words, diagrams, or any other visual representation that is meaningful to the learner (Arwood, 1991; Gross et al., 2009). Language represents thinking (Sapir, 1949; Vygotsky, 1962); thinking is cognition, therefore a person who thinks in a language of pictures possesses visual cognition, or a visual learning system (Arwood, 1991). The concept that students create cognition in multiple ways may require a change in thinking about teaching versus learning in order to fully meet the needs of all learners (Allington, 2013; Arwood, 1991, 2011; McGill-Franzen & Allington, 1991).

Once learners have accessed information through their neurobiological learning systems, they begin to form concepts that represent underlying learning processes. The learner moves information from patterns, to concepts, to language. Within this system, there are conceptual levels of language, which the brain integrates into new information, or neural circuits that form networks. The next section will provide a description of the multiple levels of meaning that can exist within the process of language and concept acquisition.

Levels of Concepts

Piaget (1959) described cognitive development in stages that occurred during certain age milestones during a child’s life: sensorimotor from birth to two years old, preoperational thinking from two to seven years old, concrete from seven to eleven years old, and formal cognition from eleven years old to adult. For the purposes of language acquisition, these descriptors will help in describing conceptual levels of language (Arwood, 2011; Carroll, 1964). This is not a description of the development
of concepts, but of the displacement and semanticity required to understand a concept, so in this way, conceptual levels relate to the use of concepts as a function of language (Arwood, 2011).

For the purposes of concept level description, at the sensorimotor level, the learner is an extension of the sensory input with limited verbal concept development. At this level, the child is able to hear the parts of acoustic wave, see particles of light or photons in the cones and rods, and feel the edges of objects and people through the shapes of movement of hands, mouths, etc. Observable output is often a motoric response to which others assign meaning. This interconnection between the child wired to connect to the environment and the world around the child; assigning meaning through sensory input results in a level of sensori-motor cognition.

As the sensory input begins to be recognized by the brain through multiple firings of connected neurons over time and place, the concepts begin to develop in relationship to what the child’s brain has experienced. These experiences result from the assigned meaning of others to what the child is able to process. This period of thinking can be described as preoperational (Arwood, 2011; Carroll, 1964; Piaget, 1959). When perceptual patterns have organized on a neurobiological level into circuits of firing neurons, there is enough inhibition and integration of information for the learner to acquire concepts at this level (Arwood, 2011). At this level, perceptual patterns are recognized, but concepts are limited to the here and now, or preoperational development, what the children can see, touch and feel for themselves. Peirce (1902) referred to this as firstness, the relationship between the child and the
environmental relationships. At this level, children are beginning to connect to others, or secondness, but there is no thirdness.

There is no otherness or thirdness at this preoperational level because concepts only exist as they relate to oneself. For example, if a child has a bicycle, the child would assume that all bicycles are like the child’s bicycle; or the child might be surprised when another bicycle looks different. Concept acquisition at this level could also be described as egocentric in nature (Dewey, 1910; Halliday, 1977; Vygotsky, 1962).

At the concrete level of concepts, learners have enough conceptual overlap of information that they can see others’ points of view and understand that there are multiple representations of concepts. Language functions deepen. For example, displacement and semanticity deepen when the learner is aware that there are many different kinds of bicycles in the world, which are used for many different reasons, and not all bicycles belong to the same person.

The final level of acquisition occurs neurobiologically with the creation of interconnected neural networks to form formal linguistic functions (Arwood, 2011; Carroll, 1964; Craik, 2002). When the layers deepen to symbolically represent meaningful relationships across and among ideas (thirdness), then a formal level of concepts can occur. Formal language function represents the highest levels of displacement and semanticity because the learner can understand concepts that cannot be felt or seen. Concepts such as liberty, justice, respect, ancient Egypt, and emancipation are concepts that require many layers of meaning to fully understanding
their complexities. Formal understanding of a bicycle might manifest in the ability to design and build a bicycle for different purposes, or understanding the importance of bicycles in a discussion of the reduction of greenhouse gases in urban areas.

Formal language function is the evidence of layers of neural structures and efficient pathways across hemispheres and within many areas of the brain. Once the structures for efficient transmission, integration, and inhibition are in place, the learner is no longer dependent upon others for all learning because the learner can use the learner’s own pathways to connect and create meaning. Concrete to formal conceptualization or thinking becomes critical in the ability of the adult to function in the current social and economic context of the United States.

As previously discussed, the ability to use and access sensory information to form the neural functions needed for learning are dependent upon acquiring language through social interaction (Bruner, 1975; Carroll, 1964; Dewey, 1910; Halliday, 1977; Tomasello, 2003; Vygotsky, 1962). It could be asserted that the conceptualization, which occurs during the language acquisition process, is fundamental in the acquisition of literacy processes specifically for comprehension and shared meaning. The next section will provide an explanation of the synergy between language function and the acquisition of literacy processes.

**Language Acquisition, Functional Language, and Literacy Processes**

The formal education of children in elementary classrooms is heavily centered upon the acquisition of literacy processes (Al Otaiba et al., 2005; Bean et al., 2015; B. C. Gamse et al., 2008; Missett & Foster, 2015). Literacy processes are generally
taught by breaking up activities into skills, and then teaching the skills with the expectation that learners will apply the skills to a new situation (Heilman, 1962; Smith, 1999). Although skill based teaching and learning is the currently accepted paradigm for literacy instruction (Missett & Foster, 2015; Owens, 2010), this researcher has provided evidence earlier in this paper to suggest that the paradigm influencing current literacy processes promote limited progress. Furthermore, the teaching of skills does not fit with the previous sections describing the neurobiological learning processes as being socially and cognitively acquired through the acquisition of language. Only through a permanent change in the neurobiological system is conceptual learning present (Arwood, 2011; Illeris, 2009; Pulvermüller, 2012). The current methodology of literacy instruction classrooms, as evidenced by published curricula, does not acknowledge the critical impact of language acquisition upon literacy processes. This section of the review of literature will make a connection between empirical information regarding literacy achievement, language theory, and neuroscience.

All learners have a neurobiological learning system, which is constantly converting sensory input from the peripheral nervous system to neural input recognizable by central nervous system (Arwood, 2011; Baars, 2010), so there may be a connection between this system and the application of language acquisition to literacy processes. If a learner is showing difficulty in acquiring literacy processes, it is reasonable to assume that there exists some kind of neurobiological difficulty making meaningful connections from the sensory input (oral language, visual stimuli)
entering the peripheral nervous system into concepts and language at the cortical regions (Arwood, 2011; Baars, 2010). There is evidence that many children cannot neurobiologically use acoustic sensory input in their cognitive processing (Arwood, 1983, 1991; Laszlo & Sacchi, 2015; Lucas, 1980; Merzenich et al., 1996; Miller, 2011; Odegaard et al., 2008; Pugh et al., 2000; Shankweiler et al., 1995; Shriberg et al., 1997; Stevenson et al., 2011). This means that many learners will be unable to process the sound/letter correspondence required using an English skills based curricula to learn reading and writing processes. Research informing the connection between language, neuroscience, and literacy helps address the research question regarding how do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy?

**Language and Neurobiological Connection to Literacy**

Observable neural activity demonstrates that language structures in the brain are highly interconnected networks (Damasio & Geschwind, 1984; Finn et al., 2014; Pulvermuller, 2013a). When involved in reading activities while monitored by fMRI scans, reading activates most of the structures involved in language tasks (Katzir & Pare-Blagoev, 2006; Pascalem et al., 2014; Pugh et al., 2000). Neural activity similar to the activity seen while reading has been recorded during complex problem solving procedures shows a strong use of multiple areas of the cerebral cortex with down streaming at the frontal lobe (Baars, 2010; Frith, Bishop, & Blakemore, 2011; St Clair-Thompson & Gathercole, 2006). These prefrontal lobe involvements suggests
that the brain is fully functioning, as in the adult brain (Baars, 2010), suggesting that multiple interconnecting neural networks must be formed in order to reach such higher-level brain functioning. Therefore, higher-level thinking, language, and facets of literacy are involved in the acquisition of meaningful concepts over many years.

There is the possibility that if a learner does not have a strong, efficient system of neural language networks structures representing underlying concept acquisition (Merzenich et al., 1996; Pulvermüller, 2003; Shriberg et al., 1997), the learner will not have the function of the brain to acquire literacy processes (reading, writing, speaking, listening, viewing, and calculating). Dickinson and Porche (2011) found a predictive relationship between the language experiences of a child in pre-school and reading ability in fourth grade. Many other researchers have noted a strong connection between low language function and the later difficulties in acquisition of literacy processes (Harlaar et al., 2008; Hayiou-Thomas et al., 2010; Heath et al., 2014; Hruby & Goswami, 2011; Mancilla-Martinez, Christodoulou, & Shabaker, 2014). These studies suggest that a strong, functional language system in a young (three to five years old) learner would predict the possibility of the learner acquiring literacy processes such as reading, writing, calculating, later in school. Therefore, difficulty in acquiring literacy processes in an academic setting could be attributed to a learner’s neurobiological learning system unable to create the strong neural networks required for the acquisition and use of language. If functional language is representative of the circuits and streams that interconnect in the prefrontal cortex during executive functioning tasks such as reading, then the process of reading must be representative
of the synergy of functional language which involves the same sets of circuits and pathways to form networks.

There is also a strong connection to the acquisition of literacy processes and the formation of signs to symbols explained by social learning theory and pragmaticism. Consider the indicator, sign, and symbolic interaction previously described (Peirce, 1902; Zeman, 1977). Functional language is first acquired in the family through social interaction, but this learning continues in the school setting.

The predictive factor of functional language measured in young children and their future academic success was demonstrated by the findings of Hart (1995). This seminal study also confirmed the work of previous language theorists (Jerome S Bruner, 1975; Halliday, 1977; Vygotsky, 1962) by demonstrating that the language used in the home environment had a profound impact on the language acquisition of a child. In an extensive longitudinal study, Hart (1995) discovered that the functional vocabulary acquired by the child through social interaction with the parent was also a significant predictor of later academic success. This finding was later confirmed by multiple studies (Dickinson & Porche, 2011; Harlaar et al., 2008; Hayiou-Thomas et al., 2010; Heath et al., 2014; Mancilla-Martinez et al., 2014)

Hart (1995) noted that children living in situations with low maternal educational levels were also living in poverty, and these children had the lowest functional language. Poverty was the only factor accounted for a significant difference in language acquisition and use, negatively impacting later academic success. Poverty, as a term used when discussing the acquisition of language, is less about the income of
the parent than it is about the secondary effects of long-term poverty. Less formal education attained by parents often leads to lower paying jobs, which could lead to housing insecurity, less medical care, food insecurity, and less overall travel and enrichment experiences for the child. Hart (1995) noted that lower maternal education that resulted in lower paying jobs was also evidenced by lower maternal functional language, leading to a restricted language environment which limits the information needed for the development of a functional learning system. Since this study, many researchers have noted evidence that children in poverty struggle with the concepts they are expected to learn at school (Bhattacharya, 2010; Chatterji, 2006; Hemphill & Tivnan, 2008; Hoff, 2003; Judge, 2013; Sinatra, 2008; Skoe et al., 2013) when compared to their more affluent peers.

Children in the elementary school years (kindergarten-fifth grade) are still learners of language (firstness), in the process (secondness) of developing a full language system (thirdness). Most published curricula ask teachers to teach concepts which are formal or symbolic (thirdness) such as sound of letters, and therefore the current methodology may represent a mismatch between the functional language levels of young children who are conceptually at the preoperational level represented by the iconic (firstness) understanding of signs and the formal symbolic expectations of school.

The current educational system has replaced the acquisition of language, which represents the refinement of signs and creation of concepts, with the teaching of sounds, letters, teacher created worksheets and teacher based instructional procedures
(Al Otaiba et al., 2005; Kozol, 2005b; MacGillivray et al., 2004; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). This is occurring in the classrooms of the youngest learners, from ages two to seven, when most children are conceptually at the preoperational level. When published curricula is based upon teaching thirdness (symbols such as individual sounds and letters and digits) as the foundation of elementary literacy processes, this may represent a futile endeavor because only with a full, formal language system can a child make sense of the complex systems of formal concepts currently required by the school system.

Holdaway (1979) explained the futility of this system quite well when he wrote,

> The traditional attempt to simplify learning by dividing the literacy processes into an ever-increasing list of minor skills is self-defeating. What in the abstract seems logically sound – the breaking of complex wholes into parts – turns out to be quite illogical in the classroom, especially when the crucial learnings are concerned with the interrelationship of parts within organic functioning (p. 190).

The whole is greater than the sum of its parts (Arwood, 1983; Lucas, 1977; Peirce, 1902); and, a young learner will use language to seek to find the contextual relationships between meaningful concepts over the unconnected, sub-skills currently emphasized in curricula. Without the requisite language to find the connections, the learner is left with meaningless tasks.

Language function and neural structures have a direct impact upon the acquisition of literacy processes. Current education systems are lacking in classroom applications of this connection between the function and structure of language and the brain the ability of a child to access literacy processes. In order to give more learners greater access to literacy acquisition, there may need to be a shift in thinking.
surrounding current literacy instructional practices that align with the theoretical framework of neuroeducation. The next section will suggest several shifts in thinking based upon previously explored literature, representing a paradigm shift that may ultimately guide educators to practices aligned with neuroeducation, helping to address the research question asking What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?

Neuroeducation – A Paradigm Shift

A review of the literature regarding current literacy practices contrasted with the literature behind the triangulation of language, cognitive psychology and neuroscience (neuroeducation) reveals a difference in underlying theoretical constructs for learning than is currently practiced in schools. When learning needs and instructional are not aligned, this is represented in the educational system by large groups of children who are having difficulty in the current educational setting. When compared to fifteen years ago, there is a significantly higher identification of children on the autism spectrum (Mitka, 2010; Committee on Oversight and Government Reform, 2012), dyslexia (Gabrieli, 2009; Peterson & Pennington, 2012), and Attention Deficit Disorder (Getahun et al., 2013; Polanczyk et al., 2014), all of which are characterized by difficulties in auditory processing. Children in poverty with low functional language, continue to fall behind their more affluent peers academically
(Chatterji, 2006; Judge, 2013; Skoe et al., 2013; Wamba, 2010). Nation-wide, only 40% of children demonstrate proficiency in math and reading (National Center for Education Statistics & Hager Sharp, 2013).

There has recently been call for change in the current system across multiple disciplines and stakeholders (Carew & Magsamen, 2010; Christodoulou & Gaab, 2009; Coch & Ansari, 2009; Ferrari, 2011; Fischer, 2009; Mason, 2009; Sawyer, 2010; Wamba, 2010). Parents and educational leaders are calling for less high stakes testing and are asking teachers and administrators to see their children as whole persons, not as test scores (Berliner, 2011; Ravitch, 2010; Rothstein, 2008). It has been suggested that the continued slide in academic achievement within the current system is a social justice issue because we have a legal responsibility to allow all children to learn (Hurder, 1997; Kozol, 2005b; Rebell, 2012; Rioux & Pinto, 2010). Cognitive neuroscientists are calling for a meaningful integration of current research into educational practice (Carew & Magsamen, 2010; Ferrari, 2011; Fischer, Goswami, & Geake, 2010). The calls from multiple disciplines (Arwood, 2011) for change suggest that there is a dissonance between currently accepted pedagogy and observable outcomes of learning in children.

This dissonance between the responsibility to educate all children and measurable results using the current educational paradigm could signal the need for change in order to meet the needs of all learners. The neuroeducation model used in this study requires the overlap of language, cognitive psychology, and neuroscience, representing a triangulation of science and theory from multiple disciplines. There is
evidence, using this triangulation, of the current methodologies used in elementary classrooms not matching what is known about language acquisition, neuroscience, and their impact on literacy processes. A paradigm could be described as a concept accepted by most people in an intellectual community because of its effectiveness in explaining a complex process or idea (Merriam-Webster, 2004). Therefore, a paradigm shift could be described as change in one way of thinking to another. This section will describe a fundamental shift in ways of thinking about learning in order to better match the literature on the impact of language and the neurobiological learning system, and the acquisition of literacy processes.

The current educational system utilizes beliefs from cognitive psychology (Anderson, 2010; Finn et al., 2014; Lucas et al., 2014; Rinne & Mazzocco, 2014) in regards to attention, memory, listening, emotions, intentions, beliefs, desires, perceptions and the acquisition of knowledge for designing pedagogy. The current educational setting uses observable behaviors to make assumptions about the mindset, attention and learning of students. These constructs (Baron-Cohen, 1997; Thompson, 1986; Wellman, 2014) are referred to as Theory of Mind, and are derived from outward behavioral observations of a person, with connections made between the known neural structures of the brain in relationship to previously seen behavior. There is much empirical evidence currently written in the field of neuroscience about the neurology of language and learning (Damasio & Geschwind, 1984; Pulvermüller, 2012; Seger & Miller, 2010; Skoe et al., 2013; St Clair-Thompson & Gathercole, 2006), so there may be a case for shifting instructional pedagogy from the construct of
the mind to the science of the brain. This shift also asks for acknowledgement that each learner has a unique neurobiological learning system (Arwood, 2011; Arwood & Robb, 2008). This learning system requires meaningful information from the sensory receptors forming recognizable perceptual patterns which overlap to form circuit of neurons which represent the acquisition of concepts so that all learners have to opportunity to use their brain the way it learns best (Arwood, 2011).

Current instructional practices in the classroom emphasize observable products; for example, completed end of chapter questions, worksheets, standardized assessments (Bruner, 2006; Kozol, 2005a; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). The products completed by children are often in the form of repeated patterns, or surface structure repetition of direct content instruction by the teacher. Neurobiologically, there is evidence that pattern based learning through the replication of products only requires lower brain structures and relay stations (Grill-Spector et al., 2006; Macnamara et al., 2014). The information received and then replicated after teacher modeling does not integrate into streams of circuits integrating the cortical brain layers, and therefore does not form connections to neural networks, which is the functional basis of long-term or semantic memory (Baars, 2010; Bassett et al., 2011).

It is through the process of using language in meaningful social interactions that learners acquire language (Halliday, 1977; Tomasello, 2004; Vygotsky, 1962), with the acquisition of concrete to formal language needed for higher-level thinking such as problem solving and creative thought. Language acquisition is represented
neurobiologically as a process of the acquisition and connection of strong neural networks (Gallistel & Matzel, 2013; Pulvermuller, 2013a). The lack of permanent neural connections due to an overemphasis of pattern-based (fill in the blank worksheets, spelling tests, segmented literacy skills, out of context mathematical equations) practices could explain the summer learning slide often noted by educators. Therefore, it is reasonable to suggest that emphasis on the process of language acquisition through accessing the neurobiological learning system would be beneficial for the greater use of functional language in order to form permanent learning networks.

There is a widely accepted cultural norm in the United States to find the problem, then fix the problem. For example, if a person has a broken arm, put a cast on the arm to fix the bone. Or, if a car part is defective, initiate a recall and fix the part; in both cases, one finds the deficit, then fixes it. While a find the deficit and fix it model may provide results in hospitals or factories, this principle does not always work in the process of learning (Dudley-Marling, 2007; Harry & Klingner, 2007; Tangen & Spooner-Lane, 2008). For example, if a person is paralyzed from the waist down, the person is not asked to practice walking, but they may strengthen the arm muscles for better mobility in a wheelchair because now their arms are their strength. If a person is blind, they are not asked to paint a landscape, but they learn Braille so they can metaphorically see into another world, using their fingers for sensory perception. When a person is deaf, they are expected to have intervention for full oral speech patterns – or use American Sign Language and other visual cues to
communicate. In all of these cases, if the first example was expected, the person would be involved in a futile effort to strengthen a part of the body which cannot function in the way it is being asked to function.

There is evidence from fMRI scans that for some learners, the temporal lobe is not integrated with activity in the occipital lobe (visual input) or activity in the parietal lobe (motor movement of the eyes) during a reading task (Merzenich et al., 1996; Miller, 2011; Stevenson et al., 2011). The current model would suggest that the best course of action would be to strengthen the temporal lobe through practicing by receiving acoustic sound patterns (Merzenich et al., 1996; Odegard et al., 2008; Peterson & Pennington, 2012), which represents a deficit model because the person is asked to practice using a part of the brain with the weakest neural activity. In the current education system, there is a strong bias towards fixing the learning system of a person so that they learn with the auditory features of the English language. However, as discussed later, a paradigm shift would recommend that an emphasis be placed on the way that visuals create concepts and language for literacy for an emphasis on strengths (Arwood, 2011).

There is strong evidence that the brain’s neuroplasticity (Doidge, 2007; Finn et al., 2014; Yoncheva, Wise, & McCandliss, 2015) will allow the occipital and parietal lobes to receive and integrate the information received from the print on a page into existing neural networks without using the weaker temporal lobe. This would allow the learner to use the strength of their neural structures for learning. Working with the
learning system the person *has* to strengthen the neural structures that are the most efficient is a *strength-based* model.

Many of the classroom instructional practices place a heavy emphasis on the role of teacher as the giver of all information and the final judge of the quality of learning evidenced by the student (Al Otaiba et al., 2005; Owens, 2010; Simmons & Kame’enui, 2003; Tivnan & Hemphill, 2005). Much time, and professional development, is spent on teacher created lesson plans, daily goals, objectives, and outcomes. Teachers design the room, the rules, the projects and the procedures of a classroom. Teachers usually present information using oral language, or in a way in which they are comfortable imparting information. Student activities are based upon teacher plans and objectives, often requiring children to imitate the teacher model to receive credit for completion. In this model, if a child cannot find meaning in the environment created and controlled by the teacher, the child is given a diagnostic label (Finn et al., 2014; Mitka, 2010; Polanczyk et al., 2014; Committee on Oversight and Government Reform, 2012) and is expected to be educated by professionals other than the classroom teacher, to meet the child’s learning needs.

The neuroscience of learning informs the educator that in order for the child to learn, information must be received by sensory receptors, sorted into recognizable perceptual patterns, overlapped to form neural circuits, then layered to form the neural networks needed for language (Arwood, 2011; Arwood & Robb, 2008; Pulvermüller, 2003). In order to shift the paradigm about classroom instructional practices from teaching to learning, there must be recognition of the neurobiological learning system
of the child, which may require teachers to adjust the presentation of information to match the way students learn concepts. When the educator acknowledges the neurobiological learning system underlying the need for a change in thinking, the focus changes from teaching of surface structures to learning deep meaning. Shifting the instructional process from an emphasis on the teacher to meeting the learner’s needs results in a change of educational focus from mind to brain, parts to whole, products to process, and deficits to strengths. If instructional practices have shifted to reflect a neuroeducation literacy model, the literature suggests that literacy data, collected from a classroom environment based upon language acquisition and function, may provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift, thereby addressing the final research question of this study.

Conclusion

During the past thirty years, Arwood (2011) has collected evidence of the permanent and positive changes in children through a paradigm shift in thinking and practice representing neuroeducation. This researcher has historical data reaching back fifteen years showing evidence of exceptional growth in the literacy processes of children (Arwood & Robb, 2008; Arwood, Brown, & Robb, 2005) when classroom practices matched the neurobiological learning systems of children as described by the NLLT. Data collected in pilot studies from the last three years also provide evidence of language growth (through analyzed language samples) and literacy outcomes
(standardized test data) as an outcome of classroom practices reflecting the implementation of the previously described paradigm shift.

There is ample evidence in the literature to validate the efficacy of a shift in classroom practices to better meet the learning needs of children through an acknowledgement of the impact of language function on literacy acquisition (Hart, 1995; Hayiou-Thomas et al., 2010; Hoff, 2003; Pascalem et al., 2014; Skoe et al., 2013; Smith, 1999; Smith & Goodman, 2008; St Clair-Thompson & Gathercole, 2006). There is also strong evidence to support change in instructional practice to create a better match with the neurobiological functions required for the reception of information because current practices do not account for current learners’ needs (Damasio & Geschwind, 1984; Finn et al., 2014; Gallistel & Matzel, 2013; Göetzmann & Schwegler, 2010; Pulvermuller, 2013a; Szücs & Goswami, 2007).

Given the evidence of the need for educational change, this research investigated several research questions. With each research question, the reader will find a short description of the methods suggested in Chapter Three to address each question.

First, *what are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?* To address this question, a chart was created from the theoretical and conceptual frameworks presented in this chapter addressing the current tenets, their theoretical frameworks, and relevant classroom practices.
Second, what new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment? Similar to the first research question, a chart was created from the theoretical and conceptual frameworks presented in this chapter addressing tenets representing a shift in thinking from teaching to learning, their theoretical frameworks, and suggested classroom practices. The suggested classroom practices and the neuroeducation tenets are utilized to fully explore research question number three.

Third, how do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy? This question led to transcribing a learning event from an elementary classroom. Then the researcher coded the event first (primary coding) through the lens of neuroeducation (cognitive psychology, neuroscience, and language). Secondary coding noted evidence of deep language structure, cognitive neuroscience, and language function within the transcription; this data was also presented as a table.

Finally, can literacy data, collected from a classroom environment based upon language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift? To answer this question, the researcher created nine years of summative literacy data tables with descriptions of changed classroom practices as they evolved to match the tenets of the neuroeducation
model used in this research. A final table with nine years of summative data was also designed to help the reader quickly ascertain the effectiveness of the suggested paradigm shift.

Chapter Four provides an analysis of the current paradigm influencing literacy practices, the results of the analysis of historical data, a transcription of the language used during neuroeducation based language events with analysis of the classroom practices using the three theoretical lenses of neuroeducation, and proposal of a model representing a paradigm shift from current learning practices. This model represents the triangulation of current research, historical data, and current neuroeducation based literacy practices. The study concludes in Chapter Five with implications for future curricula design, teacher preparation programs, and ongoing teacher education based upon the findings of this research.
Chapter 3

Research Design and Methodology

This chapter describes the methods of data collection and analysis related to the research problem and purpose of the study. The purpose of this study is to propose an alignment between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, calculating) practices in order to develop and recommend a paradigm shift in classroom learning practices that are aligned to the Arwood’s neuroeducation conceptual framework. In order to propose this alignment, four research questions were considered in this study:

1. What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?

2. What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?

3. How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged
in language acquisition events align with a neuroeducation approach to literacy?

4. Can literacy data, collected from a classroom environment based upon language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift?

The research in the study is qualitative, with four separate sections; each section will address methods utilized to explore the research questions previously mentioned. The first section identifies, then analyzes for underlying theoretical frameworks, the operational tenets influencing current classroom instructional practices. The second section uses the research base underlying neuroeducation to determine the alignment of current instructional practices for literacy processes (reading, writing, speaking, viewing, listening, and calculating) with the conceptual framework of neuroeducation.

The next section provides a case study of the researcher utilizing tenets from neuroeducation paradigm to design and implement learning opportunities for the literacy processes. The transcription of classroom learning events will also be analyzed to provide evidence of the neuroeducation framework within the implementation of classroom learning events. The final section provides an analysis of descriptive statistics from nine years of summative (end of year) and growth (beginning of year to end of year) literacy data to determine the effectiveness of a neuroeducation literacy model. The literacy data provided represents summative outcomes of a classroom based upon the neuroeducation theoretical frameworks. In short, this methodology explores what theories of learning influence tenets in
education today, how those tenets shift when matched to the literature, how the new
tenets can be identified in a neuroeducation based classroom, and the effectiveness of
classroom practices based upon a paradigm shift to a neuroeducation based classroom.

**Analysis of Current Educational Practices**

In order to determine if the literature regarding language acquisition and
function examined through the lenses of cognitive psychology, neuroscience, and
language (neuroeducation) could translate into a change in current pedagogy regarding
teaching and learning, the researcher created a table to examine common tenets
currently influencing classroom instructional practices. The purpose of this section is
to identify and analyze the theoretical and conceptual frameworks underlying current
literacy processes and instructional practices.

First, common instructional practices found in elementary classrooms were
identified. These instructional practices are used to help children learn to read, write,
think, speak, listen, view and calculate. The researcher has been an elementary
classroom teacher for twenty years; therefore is familiar with classroom instructional
practices prevalent in schools today. In addition, common instructional practices can
also be found in published curricula across multiple subject areas.

As the instructional practices were identified, each was examined to determine
their underlying theoretical foundations from a review of the literature. When each
practice was identified within the literature base, several common themes emerged.
For example, observational checklists used in classrooms to ascertain attention,
memory, effort, or self-regulation has their foundations in an area identified by
psychologists as Theory of Mind. Instructional practices were grouped by their similar theoretical research base. After the process of grouping instructional practices according to their underlying theories was completed, five major theoretical tenets were identified. The tenets, derived from the literature underlying current practices, are described within a figure, *Analysis of Tenets within the Current Paradigm Influencing Teaching and Learning*, in Chapter 4.

The *Analysis of Tenets within the Current Paradigm Influencing Teaching and Learning* provides structure to examine current cultural tenets influencing teaching and learning to delineate the theoretical frameworks of these tenets to provide a clear understanding of their conceptual models.

The identification of the conceptual frameworks for current tenets influencing teaching and learning decisions made regarding instruction in the classroom may allow the researcher to determine if current literacy practices translate into neuroeducation literacy practices, or if new practices should be suggested that align with neuroeducation in order to allow all learners access to literacy processes.

**Analysis of Tenets Representing a Neuroeducation Paradigm Shift**

This researcher has proposed a paradigm shift from the current model of teaching to a neuroeducation model of learning which is based upon examining the literature regarding learning and literacy from the overlap of cognitive psychology, language theory, and neuroscience. The development and analysis of tenets representing a paradigm shift was included to provide clarification of the theoretical
differences between the current paradigm influencing instructional design and implementation, and a neuroeducation based paradigm.

First, the researcher used the literature base to determine a neuroeducation definition of learning, language and literacy. Through this process, specific theories regarding learning and language emerged from the three lenses of neuroeducation as critical for the acquisition of literacy processes (reading, writing, thinking, viewing, speaking, listening, and calculating). From the specified theories, three tenets were developed that represented a neuroeducation theory of learning, meaning that each tenet was the result of a theoretical overlap of language, neuroscience, and cognitive psychology.

From the theory underlying neuroeducation, tenets were identified then practices were aligned to provide instructional examples aligned to the theory found in the literature. The practices identified in the result section emanate from the fieldwork completed by the researcher before the parameters of this study began. As the researcher made a shift in thinking about teaching and learning to match the body of literature regarding the learning process, instructional practices were developed. The shift in practices was noted in daily lesson plans that were archived for review as needed. The classroom practices from the lesson plans were identified for this research then aligned to the tenets identified through the literature. As this is an emerging field, instructional practices aligning to a neuroeducation paradigm are not commonly taught or used, so this researcher had to turn to their own practice to provide instructional examples. However, the instructional practices identified as aligning with
neuroeducation provided in the results of this study have been previously published (Arwood, Brown & Robb, 2005; Arwood & Robb, 2008). The *Analysis of Tenets Representing a Neuroeducation Paradigm Shift* figure provided in Chapter 4 will display the alignment between theory, tenets, and practice.

In addition, the researcher wanted to provide visual alignment between the neuroeducation model and the tenets developed from the review of literature.

![Figure 3.1. Arwood’s neuroeducation model.](image)

The Venn diagram was used to describe a model for classroom environments representing neuroeducation. The models align to the three tenets developed from the literature. Three figures are provided in Chapter Four representing classroom models aligning to the literature-based tenets.
Analysis of Current Neuroeducation Literacy Practices

This research included a case study with an “in-depth description and analysis of a bounded system” (Merriam, 2014, p. 40) in order to determine if the learning practices utilized in a second grade classroom, focused on language acquisition and function, align to the neuroeducation model. The bounded system in this study is the use of instructional practices informed by the literature regarding language acquisition and function overlapping principles of neuroscience.

The teacher/researcher recorded classroom literacy practices informed by the literature regarding language acquisition and function overlapping principles of neuroscience. The teacher/researcher authoring this study has been piloting and refining neuroeducation based literacy practices over the past fifteen years (Arwood, 2011; Arwood & Robb, 2008) however, this is the first time those literacy practices have been recorded as part of a research study. The purpose of analyzing the practices utilized by the classroom teacher is to provide validity for the design of the practices by proving their theoretical alignment to the neuroeducation framework as defined by the literature review. If classroom practices are grounded in neuroeducation conceptual frameworks, evidence should be found of the conceptual frameworks within the interactions between child and adult in the learning event.

Setting and Participants

The population used for this study is a class of 26, second grade students ranging in age from seven to nine years old. There is only one child identified with special learning needs with an Individual Education Plan. All of the students speak
English as their primary language. This is a K-5 public school in a large, urban school district with approximately 500 students total. The school-wide population has 14% of students on free or reduced lunch, defined by the federal government as students with family incomes at or below the poverty line. IRB approval was granted for this data collection one month before the video recording occurred. The IRB committee determined that the data collection was within the scope of a typical classroom day, therefore posing no risks to the research subjects (students in the classroom).

**Data Collection**

The researcher used an iPad to acquire a digital recording; the digital recording was then transferred to iMovie where the researcher listened to the video in order to transcribe the learning events. The recording primarily focused on the face and actions of the researcher, but recording equipment did record other voices within range, including students. The digital video record data is archived for research purposes and all legal guardians of the students were informed of the recording purpose and processes. The researcher chose six lessons from a six-week study of ants to record and transcribe word for word the language used by teacher and student.

Six lessons were chosen from the ten because of the amount of time available for transcription within the scope of the study. Some lessons were similar in format, so ones that were similar within the ten were not recorded. Lessons to be recorded were also determined by the availability of another adult to help with the recording to provide clear sound and visuals for the transcription. All raw recordings have been
archived to refer to as needed. All transcriptions have been also been archived. Recording language throughout an entire day would have been difficult to transcribe and hard to record due to technical limitations. The recording primarily focused on whole class lessons specifically designed to increase language acquisition and language function so the data collection did not become too broad for timely analysis. The lessons are noted as event-based learning opportunities. Event-based learning in a classroom is “…a story with agents, actions, and objects in relationship with each other to develop a preoperational context” (Arwood, 2011, p. 383). For the purposes of this research, six event based learning opportunities were recorded with whole class products demonstrating the learning process. Photographs of the event-based learning were included throughout the analysis of the transcription to add clarity to the methods involved in the classroom learning opportunity. The recording of the learning events represents the time spent in whole class involvement when one voice at a time is sharing ideas, ranging between 25 and 30 minutes. The researcher was unable to record times when students were engaged in multiple (partner or small group) discussions due to the limitations of the recording device to accurately record single voices within multiple speakers. However, these small group or partner learning times are noted in the transcription of the learning opportunity.

Data Analysis

Three of the six learning events were analyzed for alignment with the frameworks of neuroeducation. The three learning events chosen provide the research with the range of various learning opportunities within the neuroeducation classroom.
Six learning events were recorded in order to provide the researcher with a plethora of data to choose from for this research, and they represent 80% of the whole group learning involved in the classroom study of the concept of ants. Some of the six learning events recorded were similar in structure (and were therefore eliminated from analysis, but the transcription is available); the three events chosen for coding in this study represent class events, with different final products in order for the researcher to code data from varied classroom experiences.

The purpose for the analysis of the transcription of classroom language events was to determine if classroom practices were in alignment with a neuroeducation paradigm shift as established in the review of literature. The analysis began with first cycle structural coding (Saldana, 2012) of the transcription data using the three theoretical frameworks of neuroeducation; specifically theories of cognitive psychology and language theory. Structural coding was chosen because the researcher approached the coding of the transcript data with predetermined topics already selected (Merriam, 2014; Saldana, 2012), which were the three lenses of neuroeducation.

The purpose of the first cycle coding was to provide an initial connection between classroom practice and neuroeducation theoretical framework, thereby addressing the research question regarding how do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events, align with a neuroeducation approach to literacy. The first cycle coding was recorded in a two-
column chart with the transcription of classroom language on one side and the evaluation on conceptual underpinnings using the neuroeducation framework on the other side. Interactions between the teacher and student (verbal, drawing, reading) were identified throughout the learning event and coded as the theoretical frameworks of neuroscience, language, or cognitive psychology, reflecting research established in the review of literature. Interactions were initially coded to one of the theoretical frameworks, with elements within the theoretical frameworks described. For example, a verbal interaction was coded as language theory then described as belonging in language theory because there were various semantic relationships (language deep structure) refined between the learner and the adult. Secondary coding resulted from the descriptions of the interactions as defined by the three theoretical frameworks of neuroeducation. Further delineation regarding the specificity of features within cognitive psychology and language function and acquisition theories resulted in second cycle coding.

In order to fully explore the connection between the classroom practices transcribed in this research and their alignment to a neuroeducation approach to literacy, second cycle coding (Merriam, 2014; Saldaña, 2012) was utilized. Within each theoretical lens of neuroeducation identified in the first cycle coding, additional theoretical constructs were evident, providing the second cycle codes. The second cycle codes align to the primary codes; all secondary coding terms were established through the review of the literature. The connection between the coding of identifiable overlap of the lenses of neuroeducation (cognitive psychology, neuroscience, language
theory), the coding of their underlying theoretical basis, and practices for literacy processes in the classroom allows for a replicable analysis of future classroom learning events.

Within the primary coding of theoretical framework of neurocognitive psychology, there was evidence of *semantic features* of print. For example: adding suffixes to words, identifying compound words, defining words in relationship to other words through activating prior knowledge (memory). The coding also found examples of *visual images*, such as the shape/edges of words, and adding drawings or graphics to words, connecting graphic images with arrows and lines; all theoretically aligning with concepts of cognitive neuroscience. Finally, the transcript contained reference to *levels of conceptualization*, from preoperational to concrete, as students encountered new concepts within a formal subject such as the study of ants. *Semantic feature analysis, visual image analysis, and levels of conceptualization* form the second cycle coding of classroom learning events within the primary coding of cognitive psychology.

Within the first cycle coding identification of language theory, two areas of second cycle theoretical areas emerged; the features of the *deep structure* of language, and the use of *linguistic functions* by the teacher for the refinement of semantic meaning. All terms used for this second cycle coding have been identified and defined within the review of literature; in this way, the literature informed methods used in this research. Second cycle coding of the deep structure of language identified evidence of the specific processes of language. *Semantic relationships* represent a language
process that represents the cognitive development of the connections among the
basic concept of people, their actions and the objects through which they interact.

Expansion is a language process that is represented by increasing sentence structure
complexity. Extension is a language process by which meaning is added to underlying
thought. Finally, modulation represents a change in meaning by the change or addition
of morphemes. In addition, coding is identified for student use of language meaning to
note a phenomenon by which the surface form of language becomes restricted as the
learner integrates multiple conceptual relationships into the deep structure of semantic
language. The use of language function through the acquisition of concepts was also
defined through second cycle coding.

Continued second cycle coding of language function identified various
processes of language; all language function are defined within literature (Arwood,
2011; Carroll, 1964; Clark, 1977; Clark, 1978). Displacement is a linguistic function
of cognition that increases the meaning of ideas away from the physical source of the
idea. Semanticity refers to the increase of meaning for any concept. Productivity is a
function of language that allows the learner to represent meaning in multiple ways
about a subject. Flexibility is an expanded language function that results in the learner
using language about a subject in multiple places and situations. Finally, the function
of efficiency represents underlying overlap of meaning of concepts and increased
semanticity, allowing the learner to represent concepts with less redundant language
surface structures.
Figure 3.2 provides a visual reference to the levels of coding. The chart is provided to give the reader a concise view of the levels of coding. Although this representation is linear in form, the function of language allows for overlap between specific areas.

The results of the first and second cycle coding will be provided in a table found in Chapter Four noting the frequency of use within three, 25-30 minute whole
class neuroeducation based learning events. Therefore, there should be multiple instances of all identified areas of the concept through language acquisition process revealed within the analysis of the transcription.

**Analysis of Historical Data**

To determine the effectiveness of a neuroeducation approach to literacy processes, literacy data, collected from a classroom environment based upon language acquisition and function was analyzed and presented. This researcher had collected literacy data spanning fifteen years from classrooms representing over 200 students. The classroom literacy practices utilized during this time reflect an alignment with neuroeducation framework. Although some of the data collected has been published (Arwood, 2011; Arwood & Robb, 2008), this researcher examined published and unpublished historical data to fully describe the learning outcomes on mandated testing from a classroom engaged in language acquisition processes represented by the NLLT.

**Data Collection**

Nine years of data in a first grade, high poverty (defined as 75% or more students on Federal Free or Reduced Lunch) classroom was collected using the Developmental Reading Assessment. The Developmental Reading Assessment (DRA) is a method for assessing and documenting primary students' development as readers over time. The purpose of the DRA is to identify students’ reading level, defined as a text on which students meet specific criteria in terms of accuracy, fluency, and comprehension. The assessments are conducted during one-on-one reading
conferences as children read specially selected assessment texts. Leveled texts, which increase in difficulty, are used for the assessment. The teacher records the oral reading of the student by noting word errors. After the oral reading, students retell the story using their own language. An error analysis informs an accuracy score for the text, and the retell informs a comprehension score for the text.

The school district where the DRA is given determines the *meeting level* text for each grade, so an expectation is created for the amount of growth required between grade levels to be considered *meeting* grade level standards as measured by the DRA. For the time period of this data collection, a Level 2 text was meeting for end of kindergarten, Level 14-16 text was determined as meeting for end of first grade, Level 24 was determined to be meeting for end of second grade, and a Level 30 was meeting for end of third grade. The end of third grade score was determined to be reflective of the reading ability needed to pass the state standardized test at grade level, which was the initial grade level of state testing. Within the school setting for this data collection, first grade teachers were asked not to test students past Level 24 using the DRA collection of leveled texts after year three of data collection so that there would be unfamiliar texts for students to read in later grades. This request began in year four of data collection.

The limitation of this assessment occurs in the method of delivery of the assessment. The classroom teacher assesses the student individually, which allows teachers to use the data collected as a formative measure to inform future instruction, but the teacher as test administer model can lead to possible scoring irregularities.
resulting in questions of reliability. However, during the course of this data collection, reading specialists outside of the classroom also performed the DRA on certain students who were part of their small group literacy support. Their DRA scores regularly aligned with the scores reported by the classroom teacher. This was part of a school wide initiative to record and track student data over time to allow for timely interventions as needed. In addition, the teacher/researcher also had a master’s degree in education with a reading specialist endorsement signifying that the classroom teacher was highly qualified to reliably administer the DRA, as confirmed by the alignment with the scores from the building reading specialists. During the first three years of the study, there was Reading Recovery support for six out of approximately 90 first grade students in the school. Reading Recovery is a short-term intervention for first graders. Specially trained teachers work individually with students in 30-minute lessons lasting from 12 to 20 weeks. The teachers working with Reading Recovery students were comparing DRA scores with the teacher during this time and found high reliability. The impact of Reading Recovery on this data is considered insignificant because so few children were served (one or two per year) and because the score in the first three years were the weakest of the collection period. However, the alignment of DRA scores provides more evidence of reliability of data collection by the researcher.

Setting

The data collected comes from nine different cohorts of students, a new group of first graders each year. Although there is data for all of the students who were assigned to the classroom, for the purposes of measuring the impact of a
neuroeducation paradigm, the data from clear and intact students is analyzed. The population of students during this nine years reflects high mobility, with up to 20% of students leaving the class because of family mobility, with new students enrolling throughout the school year, even as late as May when the school year ends in early June. In order to report student outcomes reflecting learning experiences based in a neuroeducation model, only students who have a kindergarten or early September of first grade (first week of school) DRA score and an end of first grade score (last week of school) are included in this analysis. These students are referred to as the clear and intact population for the purposes of this research. During the time of the data collection, the school had a student body with a range of 75%-85% students on free or reduced lunch, which is the designation of the federal government as student with households at or below the federal poverty level.

In addition to poverty levels that fluctuated between 75%-85%, this school had 30% of the student population designated English Language Learners (ELL). The ELL within the school represented twelve to fifteen different countries, within the researcher’s classroom, there were between five to seven home languages represented that were not English. The most common home languages during the time of this data collection were English, Russian, Spanish, Chinese, and Vietnamese. Students with an Individual Education Plan (IEP) represented between 5%-15% of students in the class each year.
Data Analysis

The primary method of analysis was a comparison of student DRA scores from each cohort. The growth of student outcomes using the DRA are measured from end of kindergarten to end of first grade. The purpose of this analysis was to determine if the students already achieved grade level expectations before entering first grade, and if there was measurable growth during the instructional year. For each student included in the cohort (clear and intact) the DRA score was noted for the beginning of first grade (September). As per district requirements, a DRA Level 2 was labeled as meeting as a student entered first grade. A DRA Level 3 or above was labeled as entering first grade as exceeding benchmarks. A DRA score below a Level 2 was labeled as not meeting grade level benchmarks when entering first grade.

Next, the end of year (June) first grade DRA level was recorded for every student with a beginning of the year score. End of year scores level 14 to 16 were labeled as meeting. Level 18 and above were labeled exceeding, and a DRA of Level 12 or lower were labeled not meeting. From this analysis, a graph was developed for Chapter Four for each year of data collection that shows each student in the cohort with their beginning and ending scores.

In the section before each graph, there is a description of the general classroom instructional environment, including specific examples of learning strategies utilized. Therefore, there are nine subsections with a brief narrative description before each figure and graph. The narrative description of the classroom changes implemented for each year is derived from lesson plans archived from each year of data collection.
This researcher saved plans developed and refined from year to year in order to make instruction changes based upon previous plans. Each year of instructional plans has a daily account of the lessons presented in the classroom with notations of various strategies used at different times during the school day and school year. The instructional narrative has been previously published (Arwood, Brown & Robb, 2005; Arwood & Robb, 2008; Arwood, 2011) but the researcher provided a more developed description for the purposes of this study.

The final component to this section was developed from the beginning of the year and end of year DRA level scores from each year of the study. For this analysis, the scores from each cohort year were divided into three categories: not meeting, meeting, and exceeding. A percentage was found for each of the three categories out of 100%. For example, if there were 20 students and four were not meeting, that was determined to be 20% not meeting out of 100% of students. Using this method of analysis, a graph is provided in Chapter Four to show the not meeting, meeting, and exceeding percentages from all years of the data collection.

**Conclusion**

There are four main sections in Chapter Three of this research study. The first section addressed the following research question: *what are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?* The methodology of the study uses a table to explore the research base underlying
tenets (beliefs) influencing current classroom instructional practices and their manifestation in classroom instruction. The next section used the research base established in Chapter Two as research codes were applied for the development of a table for the purpose of determining the alignment of tenets suggested within a paradigm shift to neuroeducation and their manifestation within the classroom as related to research question two. The third section provides a case study of the researcher utilizing a neuroeducation approach for the acquisition of literacy processes using structural and theoretical coding in order to find evidence of the theoretical basis of literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) in an elementary, urban classroom engaged in language acquisition events designed to align with a neuroeducation approach to literacy. Finally, an analysis of descriptive statistics from nine years of literacy data was provided to determine the effectiveness of a neuroeducation literacy model. The triangulation of an analysis of current paradigm influencing teaching, analysis of tenets within a suggested paradigm shift, historical data, and current neuroeducation learning practices will be used to inform the results reported in Chapter Four.
Chapter 4

Research Findings

The purpose of this study was to propose an alignment between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, calculating) practices in order to develop and recommend a paradigm shift in classroom learning practices that are aligned to the neuroeducation conceptual framework. In order to propose this alignment, four research questions were considered in this study and each question was addressed through Chapter Two.

1. What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest supports the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?

2. What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified with evidence from a classroom aligned with a paradigm supported by neuroeducation conceptual frameworks? What classroom learning practices manifest from this alignment?

3. What do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) look and sound like in an elementary, urban
classroom engaged in language acquisition events designed to align with a neuroeducation approach to literacy?

4. What can historical literacy data, based upon language acquisition and function, collected from a classroom environment operating with the study’s neuroeducation framework paradigm reveal regarding the effectiveness of literacy processes?

Each research question is evaluated in this chapter following the methodology and design described in Chapter Three. This chapter will be organized into four sections, each reporting findings related to the four research questions in order to develop and recommend a paradigm shift in classroom learning practices that are aligned to the neuroeducation conceptual framework. The neuroeducation framework is the overlap of language theory (language), cognitive psychology (mind), and neuroscience (brain), which allows the researcher to fully consider the impact of language function and language acquisition upon learning (Arwood, 2011). In summary, the results reported in this research reports what theories of learning influence tenets in education today, how those tenets shift when theories of learning are matched to the literature, what the new tenets look/sound like in classroom practice, and the effectiveness of neuroeducation designed classroom practices.

**Analysis of Current Paradigm Influencing Teaching and Learning**

The purpose of this section of the results is to clarify for the reader the tenets within the current operational paradigm influencing decisions regarding teaching and learning to address the following research questions: *What are the tenets within the*
accepted operational paradigms surrounding teaching and learning? Where does the literature suggest the currently accepted tenets originate from, and how do these tenets within the operational paradigm manifest in commonly accepted classroom practice?

Figure 4.1 was designed to provide the reader with a concise view of the underlying theoretical or conceptual frameworks for current practices utilized in elementary classrooms. The tenets chosen for analysis were first established within the review of literature. For this analysis, the researcher used the theoretical frameworks and empirical research discussed in the review of literature to create the concise figure.

Many beliefs about instructional practices are culturally engrained into the educational system to such a degree that there are not questions asked regarding the origination of the instructional practices. This figure provides a framework to begin a discussion regarding the current paradigm surrounding teaching and learning and its manifestation in schools today.
<table>
<thead>
<tr>
<th>Tenet within the current operational paradigm</th>
<th>Theoretical frameworks supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input (teaching) = output (learning)</td>
<td>Western Psychology: information is given in one form by teacher (input), a psychological process occurs (memory, attention, perception), the same information is given back by student in the same modality (output). (Anderson, 2010; Tallal, Merzenich, Miller, &amp; Jenkins, 1998) <strong>Behaviorism</strong>: outward behavior can be controlled and reinforced with evidence of learning occurring when correct outward behavior is repeated. (Estes, 1967; Kozol, 2005b; Merzenich et al., 1996; Skinner, 1953)</td>
<td>Teacher orally presents information; students give back information orally. Imitation/matching teacher output in the same modality. Standardized minutes of instruction. Scripted curriculum.</td>
</tr>
<tr>
<td>Reductionist teaching Parts to whole</td>
<td>Behaviorism: all behavior, and therefore learning, can be reduced to it smallest components then taught. (Estes, 1967; McLeod, 2008; Skinner, 1953) <strong>Cognitive psychology</strong>: suggests that smaller units of meaning create larger meaning. (Anderson, 2010; Chall, 1999b; Foster, 2013; Greene, 1985; Heilman, 1964; Newkirk, 2009; Poplin, 1988)</td>
<td>Spelling words out of context. Vocabulary word lists. Math facts. Scope and sequence lesson design. Isolated sounds to create words (reading/writing)</td>
</tr>
</tbody>
</table>

Figure 4.1. Analysis of tenets within current paradigm influencing teaching and learning.
The purpose of this section is to address the following research question: What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?

New tenets regarding literacy were found from examining the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, calculating) practices. There is little acknowledgement of recent neuroscience research regarding the neurobiological process of learning in current literacy (reading, writing, thinking, listening, viewing, and calculating) practices, therefore current literacy practices do not provide for the integration of language theory and neuroscience represented by neuroeducation. The alignment provided in the following figure represents a paradigm shift from teaching to learning.
<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
</table>

*Figure 4.2. Analysis of tenets representing a neuroeducation paradigm shift – learning as concept.*
<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic Learning Model</td>
<td><strong>Language theory</strong>: learners use the concepts they begin to acquire new concepts by forming semantic relationship between a known idea and an unknown idea. (Carroll, 1964; Halliday, 1977; Hymes, 1964; Lucas, 1980; Peirce, 1878; Tomasello, 2003; Vygotsky, 1962) <strong>Neuroscience</strong>: the brain will create efficient pathways through inhibition and integration of sensory information using the strength of the neural structures; will rewire around neural structures that do not provide strong feedback for integration/inhibition of new sensory information. (Baars, 2010; Bassett et al., 2011; Doidge, 2007; Gage &amp; Muotri, 2012; Laszlo &amp; Sacchi, 2015; Park &amp; Huang, 2010)</td>
<td>Classroom learning events allow for multiple points of access; neurobiologically multi-modal, and multiple levels of conceptualization. Finding the neurobiological strength of the learner to develop individual strategies for concept acquisition. See the whole child as a learner instead of separate diagnosis to be addressed</td>
</tr>
</tbody>
</table>

*Figure 4.3. Analysis of tenets representing a neuroeducation paradigm shift – semantic learning.*
<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function of the Whole</td>
<td>Language Theory: the structure (parts) of oral language represents conceptual acquisition of a whole idea. Only with the acquisition of a whole concept can the parts (structure) be identified or utilized in a conventional way. (Arwood, 2011; Carroll, 1964; Dewey, 1910; Halliday, 1977; Sapir, 1949; Searle, 1970; Vygotsky, 1962; Whorf, 1944)</td>
<td>Visual flowcharts – see how the concepts are interconnected.</td>
</tr>
<tr>
<td></td>
<td>Pragmatism: the whole is greater than the sum of the parts. The functional use of language represents a deep understanding of layers interconnected semantic relationships. As concepts are acquired, they become symbolized between agents to form conventional language. (Arwood, 1983; Peirce, 1878, 1902; Zeman, 1977)</td>
<td>Reading is taking ideas from the page - the whole idea greater than the component parts.</td>
</tr>
<tr>
<td></td>
<td>Psycholinguistics: Only with the whole meaning of a concept can the literacy process of reading occur because the underlying function of the concepts allow access to the structure of language represented in text. (Clark, 1977; Clark, 1978; Holdaway, 1979; Smith, 1999; Smith &amp; Goodman, 2008)</td>
<td>Writing is showing ideas- use how a whole word looks to write the idea – visual concept dictionaries.</td>
</tr>
<tr>
<td></td>
<td>Neuroscience: Language is represented neurobiologically by neural networks using many regions and relay stations of the brain; brain function represents a synergy between different areas of the whole brain. (Arsenault &amp; Buchsbaum, 2015; Gallistel &amp; Matzel, 2013; Geake, 2004; Hruby &amp; Goswami, 2011; Mohr et al., 1996; Pulvermüller, 2005)</td>
<td>Drawing before writing allows the reader to see the whole idea.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asking why and how- answering the big questions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Classroom learning events- layer conceptual meaning to acquire function in the frontal lobe for formal thinking.</td>
</tr>
</tbody>
</table>

*Figure 4.4. Analysis of tenets representing a neuroeducation paradigm shift – function of the whole.*
A paradigm shift represents a change in thinking regarding thinking about certain beliefs. Figures 4.5, 4.6, and 4.7 are provided so the reader can see how the current tenets align with the proposed paradigm shift. Tenets from the current paradigm are directly aligned with tenets represented by a neuroeducation paradigm.

<table>
<thead>
<tr>
<th>Tenet within the current operational paradigm</th>
<th>Manifestation in classroom instructional practices</th>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input (teaching) = output (learning)</td>
<td>Teacher orally presents information; students give back information orally. Imitation/matching teacher output in the same modality. Standardized minutes of instruction. Scripted curriculum.</td>
<td>Learning as Conceptual Process Learners acquire concepts through meaningful social interaction; language represents concepts. Learning is a dynamic process between the language user, meaningful sensory input, and the outside user of language helping name the input. Multiple overlapping patterns form concepts and through the acquisition of layers of concepts, the learner acquires language. Structures acquired through the use of the learning system semantically develop language and facilitate the acquisition of widespread neural networks allowing for process of inhibition/integration of new information, increasing neural networks through stages of conceptual layers.</td>
<td>Preoperational Stories. Event based learning. Visual Concept Dictionaries. Drawing before writing. Student created projects. Students using natural language to disseminate knowledge. Student products are unique—represent individual learning process.</td>
</tr>
</tbody>
</table>

*Figure 4.5. Learning as a conceptual process.*
<table>
<thead>
<tr>
<th>Tenet within the current operational paradigm</th>
<th>Manifestation in classroom instructional practices</th>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deficit Based Intervention</strong></td>
<td>Double dose of same information. Interventions design to fix weakness in child. Diagnostic labels for performance outside of normal. Change the child to fit the norms.</td>
<td><strong>Semantic Learning Model</strong> Learners use the concepts they begin to acquire new concepts by forming semantic relationship between a known idea and an unknown idea. The brain will create efficient pathways through inhibition and integration of sensory information using the strength of the neural structures; will rewire around neural structures that do not provide strong feedback for integration/inhibition of new sensory information.</td>
<td>Classroom learning events allow for multiple points of access; neurobiologically multi-modal, and multiple levels of conceptualization. Finding the neurobiological strength of the learner to develop individual strategies for concept acquisition. See the whole child as a learner – not separate problems to be addressed through discrete silos of expertise.</td>
</tr>
<tr>
<td><strong>Theory of Mind</strong></td>
<td>The ascertaining, through observation, of the impact of memory, attention, effort, mindset, perception, self-regulation, preference, confidence and other psychological processes on learning.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 4.6. Semantic learning model.*
<table>
<thead>
<tr>
<th>Tenet within the current operational paradigm</th>
<th>Manifestation in classroom instructional practices</th>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reductionist teaching Parts to Whole</td>
<td>Spelling words out of context.</td>
<td>Function of the Whole</td>
<td>Visual flowcharts – see how the concepts are interconnected.</td>
</tr>
<tr>
<td>All behavior, and therefore learning, can be reduced to its smallest components then taught.</td>
<td>Vocabulary word lists.</td>
<td>The structure (parts) of oral language</td>
<td>Reading is taking ideas from the page - the whole idea greater than the component parts.</td>
</tr>
<tr>
<td>Smaller units of meaning combine to create larger meaning.</td>
<td>Math facts.</td>
<td>represents conceptual acquisition of a whole idea. Only with the acquisition of a whole concept can the parts (structure) be identified or utilized in a conventional way. Only with the whole meaning of a concept can the literacy process of reading occur because the underlying function of the concepts allow access to the structure of language represented in text.</td>
<td>Writing is showing ideas - use how a whole word looks to write the idea – visual concept dictionaries.</td>
</tr>
<tr>
<td></td>
<td>Scope and sequence lesson design.</td>
<td>Pragmaticism explains that the whole is greater than the sum of the parts. The functional use of language represents a deep understanding of layers interconnected semantic relationships.</td>
<td>Drawing before writing allows the reader to see the whole idea.</td>
</tr>
<tr>
<td></td>
<td>Isolated sounds to create words (reading/writing)</td>
<td>Language is represented neurobiologically by neural networks using many regions and relay stations of the brain; brain function represents a synergy between different areas of the whole brain.</td>
<td>Asking why and how- answering the big questions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Classroom learning events - layer conceptual meaning to acquire function in the frontal lobe for formal thinking.</td>
</tr>
</tbody>
</table>

*Figure 4.7. Function of the whole.*
Neuroeducation Learning Events

The application of theory to practice is a natural progression in the paradigm shift from teaching to learning as the educator acknowledges the neurobiological learning system of the student by matching classroom practices with the neurobiological learning system. The classroom practices/methods analyzed in this section were designed with a theoretical framework of neuroeducation, the overlap of cognitive psychology, language theory and neuroscience. Neuroeducation aligns to the conceptual framework of the Neurosemantic Language Learning Theory (NLLT), which describes the learning system by which sensory input is sorted into perceptual patterns, which are recognized and overlapped into neuronal circuits that represent the formation of concepts, which then layer in the cerebral cortex into interconnected networks of neurons, which represent language.

This section of results addresses the following research question: How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy? In order to establish the validity of the alignment of learning events with neuroeducation, primary coding of learning events was provided using the three lenses of neuroeducation: language theory, neuroscience, and cognitive psychology. Within the primary coding of the theoretical frameworks of neuroeducation, evidence was found of multiple underlying elements comprising tenets of language theory and neurocognitive psychology. Secondary recording was completed using the elements as described in
the methodology of this research. The overall purpose of the analysis of classroom practice was to provide evidence of the theoretical frameworks underlying the proposed neuroeducation tenets within neuroeducation based learning events. It is proposed that if learning events are representative of neuroeducation, the new tenets suggested in Figures 4.2, 4.3, and 4.4 should be supported by corresponding theoretical basis through the manifestation of classroom learning events.

The transcription of the classroom events has been analyzed through the consideration of the theoretical frameworks of neuroeducation: language theory, neuroscience, and cognitive psychology. If the methods are representative of neuroeducation, then elements from each theoretical framework should be evident within the course of the learning event. The researcher considered elements from each theoretical framework as discussed and defined within Chapter Two. The data was initially displayed in a chart with two columns. On the right was the transcript of the learning event with still photographs taken from the video recording and photographs of the final product of the learning process. The left side of the column was the primary coding of the transcription using the three lenses of neuroeducation. Within each theoretical lens of neuroeducation identified in the first cycle coding, additional theoretical constructs emerged, previously discussed in this research through the literature, providing the second cycle coding. The second cycle codes align to the primary codes; all secondary coding terms were established through the review of the literature. The following figure provides an example of the first cycle coding aligned to a portion of the transcript.
Teacher: Yesterday you designed a story problem but you didn’t write the words. When you write your story today, you are going to tell a story, not just say “there are two ants and two ants, how many ants” That is not what you are going to write today. You are going to write a story, so we need some ideas for parts of the story we will write today. We are going to need to know who, or what because the ‘who’ is the ants, where they are, and what they are doing in the story, and we are going to need a few math words to help you out because math has its own words too. So let’s start by thinking about the ‘who’ in our ant story problems. Raise your hand if you want to help me out by telling us a who to write.

Student: Ants.

Teacher: Ok, what specific ant did you choose?

Student: Army ants

Teacher: Army ants. How many children chose army ants, raise your hand. If you did not choose army ants for your problem, you do not have to write this idea, but if you did, I want you write this down. Here is how it looks. Make sure the shape looks right. If you chose army ants, write that down.

Activating prior knowledge represents the theoretical framework of cognitive psychology: previous experiences (memory) connect to and strengthen the associative bonds to more recent experiences. Neuroscience tells us that associative bonds of larger neural networks are created from already existing smaller pathways, or networks.

As the teacher identifies the semantic relationships for the story writing, the learners have the opportunity to expand their functional use of language through increased semanticity. Language literature tells us that the basis for conceptual understanding rests with semantic relationships.

The productivity of functional language increases the connections between literacy processes, therefore writing, reading, calculating, listening, speaking and viewing are all interconnected. Note the use of all literacy processes throughout the learner/teacher interactions.

As the students see the teacher’s hand writing the shape of the word, the brain receives sensory information about the shape of the word by perceiving the edges of the letters and about the movement of the hand creating the shape of the word, allowing for cross modal sensory input (movement/edges) recorded in the occipital lobe as part of the visual cortex as part of a language network that represents increased cognition or thinking.

Figure 4.8. Transcription with first cycle neuroeducation coding analysis.
Within the primary coding of theoretical framework of cognitive psychology, there was evidence of semantic features of print, examples of visual images, and levels of conceptualization, from preoperational to concrete, as students encountered new concepts within a formal subject such as the study of ants. Semantic feature analysis, visual image analysis, and levels of conceptualization form the second cycle coding of classroom learning events within the primary coding of cognitive psychology.

Within the first cycle coding identification of language theory, two areas of second cycle theoretical areas emerged; the features of the deep structure of language, and the use of linguistic functions by the teacher for the refinement of semantic meaning. Second cycle coding of the deep structure of language identified the following features of language: semantic relationships, expansion, extension, and modulation. In addition, coding is identified for student use of language meaning to note a phenomenon by which the surface form of language becomes restricted as the learner integrates multiple conceptual relationships into existing language. Second cycle coding of language function identified the following: displacement, semanticity, productivity, flexibility, and efficiency. The next figure provides definitions for each of the second cycle coding terms with explanations and examples from the transcript of their use in the coding process.
<table>
<thead>
<tr>
<th><strong>Neurocognitive Psychology</strong></th>
<th>Instructional Examples (Narrative) with explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Features:</strong> Parts of sensory input such as particular parts of sound or pieces of visual sensory input mark differences in meaning of concepts tagged by the teacher.</td>
<td>The sorting of semantic features of different species of ants provides the language for categorization and classification of ants based upon those features. <strong>Teacher:</strong> Army ants. How many children chose army ants, raise your hand. If you did not choose army ants for your problem, you do not have to write this idea, but if you did, I want you write this down. Here is how it looks. Make sure the shape looks right. If you chose army ants, write that down.” <strong>Teacher:</strong> To draw a queen ant, lots of people like to draw a little make believe crown, but I am not going to do that because in real life they do not have crowns, but they do have a really big abdomen and there is always a bunch of eggs, so that is how I will draw the queen ant.” Students and teacher note the meaning of ideas found in words and how these semantic patterns fit together to form a new concept. <strong>Teacher:</strong> Sometimes for your stories you will want them to be outside, outside the anthill looking for leaves… <strong>Student:</strong> it’s a compound word  <strong>Teacher:</strong> It is a compound word! What does that mean? <strong>Student:</strong> That means its two words combined to make one word. <strong>Teacher:</strong> ok, so you have out and side?</td>
</tr>
<tr>
<td><strong>Visual images:</strong> using light and movement as semantic features of visual patterns that can be seen (drawing) and then overlapped with oral or written word patterns so that the ideas or drawings (concepts) are tagged with word patterns as represented by language.</td>
<td>Students write word patterns overlapped with their own conceptual pictures in Visual Concept Dictionaries. This allows the depth of meaning to begin with the student’s thinking; the dictionary allows the student to displace the meaning and overlap other ideas to increase the meaning across others’ concepts. <strong>Teacher</strong> draws concepts while speaking (such as drawing a visual flowchart or cartooning ideas). As the teacher tags the drawn student concepts with written words in real time, the students are able to use their neurobiological learning systems to make connections across the concepts they see created by watching the movement of the teacher’s hand with what they already know, with what others will share later. As the eyes move as they watch the hand move, there are multiple avenues for multi-modal sensory input needed neurobiologically to allow for maximum neurobiological integration and inhibition of perceptual patterns required for the creation of efficient neural networks representing an increasingly complex language function.</td>
</tr>
<tr>
<td><strong>Levels of Conceptualization:</strong> Concepts represented as preoperational, concrete, or formal</td>
<td>Learners cannot put themselves into a math story problem from an ant’s point of view, so the language function of this literacy process is concrete. <strong>Students</strong> begin learning about ants by sharing a preoperational story about a time they saw or touched an ant. <strong>Student</strong> experience multiple concrete and preoperational experiences with concept regarding ants in order to allow access to formal concepts (such as the importance of ants in the larger ecosystem)</td>
</tr>
</tbody>
</table>

Figure 4.9. Neurocognitive psychology coding with examples.
### Language Deep Structure

| Semantic Relationships: understanding the connections among people, their actions and their objects in context of a shared event or activity. | The teacher identifies the semantic relationships needed for writing a story problem about ants; who, what, when where, why to establish an access point of meaning for each learner.  

**Teacher:** The harvester ants look like regular ants, they don’t have really big mandibles like the army ants but they are always carrying seeds back to their nest because they are going to take that seed and make ant bread. “  

The semantic feature of a long tongue as important to several ant predators has been drawn and written several times on the paper. The learner is connecting semantic features in relationship to ants and their predators.  

**Teacher:** This team found an very unique animal called an echidna, which is kind of a spiky looking animal the size of a cat that lives in Australia, it’s kind of like an anteater, but it is spiky.  

**Student:** it has a long tongue  

**Teacher:** yes, a long sticky tongue so it can get right down there into the tunnels with its tongue and just stick those ants on, slurp them up, and run away.”  

| Expansion: increase in language structure complexity (because, more verbs, adverbs, etc...) as a function of increase in meaning of how concept connect together. | “**Student:** in tunnels  

**Teacher:** yes, in tunnels in an anthill in a colony. So let’s go ahead and put some “where”. The ants can be in the tunnels.  

**Student:** we should write chamber  

**Teacher:** we will definitely write chamber because a lot of you put your ants in chambers doing things and of course the tunnels and chambers are all connected inside the anthill. And we have chambers where the tunnels go. Most chambers have at least two entrances so the ants can go in and out. Chambers are rooms; that’s another word for rooms.”  

| Extension: process by which meaning is added to underlying thoughts or concepts; animal with 4 legs/meows, cat, barks, dog. | “**Teacher:** Now, if you chose army ants, make sure you add a picture of army ants. I think a difference is that army ants have really big mandibles... I am going to put a picture for leafcutter ants. I am going to draw the ground and I’m going to put ants here, but I am going to draw this ant holding a leaf.”  

Extension is part of cognitive scaffolding of meaning as seen in this example.  

| Modulation: change the meaning in concepts by adding meaning to words; also referred to as inflectional morphemes (-ly, -ing, -s). | The teacher is defining the smallest unit of meaning, the morpheme –s as a marker to show the relationship in number between one and more than one ant, and provides a visual representation of the word to show that surface pattern.  

**Teacher:** and since I wrote “ants” I need to draw at least two ants because nobody has a story problem with just one ant, so we are going to make two.”  

| Pattern vs. concept meaning: unique to this study- evidence that the child has restricted use of surface structures as the child is able to state a pattern without the underlying deep meaning. | “**Student:** A lizard is one of the ants worst enemies.  

**Teacher:** Did you read why they are?  

**Student:** No, there wasn’t any part that said why.”  

The learner was not able to articulate why the lizard was an ant’s worst enemy, which allowed the teacher to determine that this was language borrowed from the book. Borrowed language surface patterns do not represent underlying concepts. Borrowed language indicates that the learner could read the words, and copy the words, but not understand the underlying semantic relationships among concepts represented by the words the child repeated.  

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Figure 4.10. Language deep structure coding with examples.
<table>
<thead>
<tr>
<th>Linguistic Functions</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Displacement:</strong> understanding ideas, which are physically distant from the physical source.</td>
<td>Learners are asked to use the language function of displacement to design a story about ants, in an anthill, from an ant point of view. Learners are asked to identify ant predators and what makes them effective predators. This requires reading, writing and drawing about animals and insects they have never seen. And it requires the children to think about ideas from another, non-human perspective.</td>
</tr>
<tr>
<td><strong>Semanticity:</strong> increasing meaning of any subject for greater specificity (ant becomes harvester ant); scaffolding meaning onto what the child knows increases the meaning.</td>
<td>Teacher: “Raise your hand if you want to help me out by telling us a “who” to write. Student: Ants. Teacher: ok, what specific ant did you choose? Student: Army ants” Teacher asks students to give ideas of verbs for what ants do. The student response is ambiguous: “Student: working? Teacher: working – that one is a little hard to choose a picture for because working can look many different ways, but we will put it on there so you can use it if it makes sense for your story. An ant can be working, helping move the eggs, they can be licking the larva to keep them moist, they could be harvesting the fungus from the leaves, so many things the ants could be doing.”</td>
</tr>
<tr>
<td><strong>Productivity:</strong> creating various utterances about the same topic (read, write, draw, listen, speak) increases the points of cognitive access or conceptual depth of meaning.</td>
<td>The productivity of language increases the connections between literacy processes, therefore writing, reading, calculating, listening, speaking and viewing are all interconnected. Students use the linguistic function of productivity when they write ant story problems. Adding math concepts to visual concept dictionary gives the learner more tools for expanded productivity as they take the concept of ants and develop a mathematical situation.</td>
</tr>
<tr>
<td><strong>Flexibility:</strong> Using ideas in multiple places for multiple purposes; using an idea at home, school, work, playground, library increases the student’s ability to increase thinking about the meaning of ideas or concept (depth).</td>
<td>The students research information about ants from books, computers and magazines. They share these ideas in partners, whole groups, while designing home ant projects, sharing finished projects with students from other grades (dissemination), the purpose of ants observed in a school compost bin, why ants are in their homes or yards…</td>
</tr>
<tr>
<td><strong>Efficiency</strong> (internal redundancy) conceptual meaning overlaps increasing cognitive meaning while limiting the structural redundancy of language – less repetition when trying express an idea. The greater the depth of meaning, the less redundant is the surface structure.</td>
<td>In this conversation, the student acquiring the language needed for full understanding of the connections between the adaptation of a spider and why that makes an effective ant predator. The teacher helps refine this understanding for greater depth of understanding resulting in better surface efficiency. “Student: Jumping spiders smell like ants. Teacher: Tell us more about what that book said. Student: Well, they smell like ants so they would let the spider into their nest sort of and then he would eat them. Teacher: What is special about ants that the smell matters more than how the spider looks? Student: Because they can’t see. Teacher: That’s right, they are all about the smell.”</td>
</tr>
</tbody>
</table>

Figure 4.11. Linguistic functions coding with examples.
The secondary coding results are provided in a *Frequency Analysis* table for each of the three, approximately thirty-minute neuroeducation based learning events.

Table 4.1

*Frequency Analysis of Theoretical Frameworks Coded from Classroom Neuroeducation Learning Events*

<table>
<thead>
<tr>
<th>Neurocognitive Psychology</th>
<th>Language Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deep Structure</td>
</tr>
<tr>
<td></td>
<td>Frequency of use</td>
</tr>
<tr>
<td>Semantic features</td>
<td>7</td>
</tr>
<tr>
<td>Visual images</td>
<td>6</td>
</tr>
<tr>
<td>Levels of conceptualization</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Semantic Relationships</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Expansion</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Extension</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Modulation</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Language meaning</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

During this learning event, there was evidence of elements from the tenets of neuroeducation 58 times in 27 minutes. The data indicates that on average two times each minute of student/teacher interaction there is evidence of the underlying elements representing a neuroeducation literacy model.
### Table 4.2
*Frequency Analysis of Theoretical Frameworks Coded from Classroom Neuroeducation Learning Events*

**Lesson #2 – Concept Poster – 28 minutes**

<table>
<thead>
<tr>
<th>Neurocognitive Psychology</th>
<th>Frequency of use</th>
<th>Language Theory</th>
<th>Frequency of use</th>
<th>Linguistic Functions</th>
<th>Frequency of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic features</td>
<td>10</td>
<td>Semantic</td>
<td>11</td>
<td>Displacement</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual images</td>
<td>6</td>
<td>Expansion</td>
<td>5</td>
<td>Semanticity</td>
<td>6</td>
</tr>
<tr>
<td>Levels of conceptualization</td>
<td>7</td>
<td>Extension</td>
<td>4</td>
<td>Productivity</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modulation</td>
<td>3</td>
<td>Flexibility</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Language Meaning</td>
<td>3</td>
<td>Efficiency</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total Frequency:** 23 | 26 | 19

Analysis of this learning event provides evidence of elements from the tenets of neuroeducation 68 times in 28 minutes. The data indicates that on average 2.4 times each minute of student/teacher interaction there is evidence of the underlying elements representing a neuroeducation literacy model.

### Table 4.3
*Frequency Analysis of Theoretical Frameworks Coded from Classroom Neuroeducation Learning Events*

**Lesson #3 – Semantic Visual Flowchart – 32 minutes**

<table>
<thead>
<tr>
<th>Neurocognitive Psychology</th>
<th>Frequency of use</th>
<th>Language Theory</th>
<th>Frequency of use</th>
<th>Linguistic Functions</th>
<th>Frequency of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic features</td>
<td>5</td>
<td>Semantic</td>
<td>12</td>
<td>Displacement</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual images</td>
<td>6</td>
<td>Expansion</td>
<td>6</td>
<td>Semanticity</td>
<td>6</td>
</tr>
<tr>
<td>Levels of conceptualization</td>
<td>7</td>
<td>Extension</td>
<td>4</td>
<td>Productivity</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modulation</td>
<td>1</td>
<td>Flexibility</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Language Meaning</td>
<td>3</td>
<td>Efficiency</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total Frequency:** 18 | 26 | 18
Analysis of this learning provides evidence of elements from the tenets of neuroeducation 62 times in 32 minutes. The data indicates that on average 1.9 times each minute of student/teacher interaction there is evidence of the underlying elements representing a neuroeducation literacy model.

**Historical Literacy Data**

The purpose of this section is to address the following research question: *Can literacy data, collected from a classroom environment based upon the literature earlier reported about language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift?*

The application of theory to practice is a natural progression in the paradigm shift from teaching to learning as the educator acknowledges the neurobiological learning system of the student by matching classroom practices with the learning system. To address the research question, this section will provide two sets of data. First, there is a description of the personal paradigm shift made by this teacher/researcher over nine years where typical literacy and instructional methods were changed to those supported by the review of literature to meet the needs of learners. Over the course of nine years, this researcher implemented the theoretical principles of the Neurosemantic Language Learning Theory (NLLT) in a first grade classroom, which aligns with the theoretical frameworks of neuroeducation. Each year, instructional methods were added and refined. A description of the instructional methods will be provided in this chapter order for the reader to understand the changes made as the data is presented. Many of the methods described in this section are listed
in Figures 4.2, 4.3, and 4.4 as manifestation in classroom instructional practices demonstrating their alignment to neuroeducation tenets of learning as a conceptual process, semantic based learning model, and learning as a function of the whole, which align to the research literature. Literacy data presented is the outcome of the tenets of neuroeducation. Literacy data is displayed both showing the growth of each student over the course of one school year through a pre-test/post-test data, and as a graph with a summative graph of all nine years in order to provide support for the efficacy of the neuroeducation paradigm.

**Assessment Tool**

The Developmental Reading Assessment (DRA) was used to measure reading progress and outcomes. As previously described in Chapter Three, the DRA is a teacher administered assessment of a student’s oral reading on a text leveled by difficulty. The levels of achievement are determined by the school district. During the nine years of data collection, Level 2 was meeting at the end of kindergarten, Level 14 is meeting for end of first grade, and Level 24 is considered meeting for end of second grade. This researcher has pre (end kindergarten) and post (end first grade) DRA scores for students during the nine years of collected data. Each year’s data will be analyzed and shifts in classroom literacy practices described.

**Year One**

At the beginning of the first year, the teacher had an M.Ed with a Reading Endorsement, and some background in the NLLT. A large percentage (35%) of students did not speak English as their first language, so the teacher incorporated
visuals into the classroom to help with vocabulary. For reading instruction, the students were in small groups determined by their DRA levels. During reading groups, the students read texts at their level as determined by the DRA. The teacher emphasized the three cuing systems: graphophonic (sound to letter correspondence) syntax (grammar rules) and semantics (meaning of words and ideas) during the small group reading time, which was 30 minutes a day for each student. Small group reading instruction was the typical model for this school. There was no published curriculum or specific curriculum design for reading instruction. The following figure shows the growth for each student as measured by the DRA.

![Figure 4.12. Year one pre-test/post-test student growth data.](image)

The first line represents the DRA score in September and the second line the DRA score in June of the academic year. Some students made enough growth to meet or exceed the grade level benchmark, while others did not even though they started in September at the same levels.

In September, 62% of students had scored a DRA Level 2 or higher, indicating meeting or exceeding grade level standards, but at the end of the year, that number had
dropped to 58%. This data reveals that most of the students who were already meeting or exceeding grade level reading standards were still meeting or exceeding, but one did not make enough progress to continue meeting grade level expectations. Students who were not meeting grade level standards ended the year not meeting. Only 62% of students reaching grade level reading standards was average for a school with these demographics, but the teacher was not satisfied with 42% of students not learning to read. The teacher reached out to a professor with expertise in language theory to possibly relate theory to practice in the classroom instructional setting.

**Year Two**

As the teacher began to work with a professor with expertise in language theory, it became apparent that making aspects of the curriculum visual was not helping the students acquire concepts visually. After some classroom observations, the professor and teacher discussed some instructional strategies based upon language theory. The teacher taught the students to use visual concept (picture) dictionaries. Visual concept dictionaries are organized by set or meaning, not alphabetically as in a traditional dictionary. In a visual learning system, categorizing words by their first letter is an arbitrary sorting which does not match the process of acquiring language. Therefore, the visual concept dictionary is organized by the interconnected relationships of concepts; relationships that connect and layer to form the larger concept of a ‘tree’.

The teacher also had the students draw their ideas before they wrote their ideas. For students who create cognition in the language of pictures, taking their visual
thoughts straight to written words is much like translation from one language to another. Drawing concepts before writing gives the learner an opportunity to take their thoughts directly from the concepts represented by visuals in their mind onto the page. Drawing concepts becomes a natural part of the writing process. The growth chart from year two showed some differences from year one:

![Figure 4.13. Year two pre-test/post-test student growth data.](image)

This year only two students overall did not achieve end of year grade level standards and four students who were not meeting grade level standards in September were meeting at the end of the year. The pre-test/post-test data also shows growth from year one. Also, 37% of the students exceeded grade level expectations this year. In addition, 37% of the students in this cohort were below benchmark entering first grade, but only 12% were below benchmark after a year utilizing some methods aligned with the NLLT. During this year, and the years to follow, the teacher did not use any systematic phonics instruction with students for literacy learning.
Year Three

Throughout the year, the teacher continued to use the methods from year two, but added some other strategies based on theories of language acquisition and function as defined in the review of literature. The students began drawing and writing on the first day of school, allowing them to gain more conceptual layers throughout the year. In addition, the teacher began drawing classroom rules, procedures, and academics as much as possible in real time, which means that the drawings happen in front of the students, which allows the multi-modal sensory access of information as the learner watches the movement of the hand create the edges of lines with a pen or pencil. Cartooning is the act of drawing the agents, actions, and objects in the context of a setting, and this was done as much as possible throughout the day.

The other strategy added this year was connecting learning events throughout the day as much as possible. If the students were learning about insects, they would read, write, draw, speak, listen, calculate and think about insects. These learning opportunities are referred to as events in the classroom. The classroom environment supported the acquisition of language through the process of experience and discovery. The teacher provided an environment for the children to learn the concepts related to a topic, such as ants, in multiple ways over time. This occurred through reading, writing, student developed projects, math problem solving, speaking, story writing, and drawing, which allowed the learner to process and layer concepts in a meaningful way.
The data showing student growth continued to show progress towards all students meeting grade level benchmark standards in reading.

This year, 52% of students *exceeded* benchmark standards in reading, up from 37% the year before. Of specific note is that when the year began, 48% of the students were not meeting, while at the end of the year, only 9% were not meeting standards in reading.

**Year Four**

Encouraged by the improvement of the students who were not meeting at the beginning of the year to meeting at the end of the year, the teacher added another strategy while using and refining previously described strategies. All learning begins with recognizable sensory input, which can begin to sort into perceptual patterns to be sent through relay stations to integrate into strengthened neural circuits, which represent conceptual understanding. These concepts begin at a preoperational level, meaning they start with how the concept relates to the experiences of the individual.
learner. Learning is also a product of social interaction, by which experiences are given meaning and value by the culture surrounding the learner.

In the classroom, the teacher can acknowledge both the social, conceptual and neurobiological needs of the learner with the use of a pre-operational story as a first shared experience in the process of language acquisition. If the classroom environment is going to begin experiencing events related to the concept of weather, the teacher may begin by speaking a story from their point of view. For example, “Learners, let me tell you a story about a trip I took to the beach as a child. My family packed up our van for a camping trip with tents, food, sleeping bags and whatever else we could need for the trip. After a long drive, we arrived at a campsite where we set up the tent, started a fire in a fire pit, and enjoyed an evening of roasting marshmallows and playing games. After dark, we all piled into our tents, ready for sleep, but during the night, the rain began to pour. When I woke up the next morning, my sleeping bag, clothes and everything else was soaked because the tent was not very waterproof and the water had seeped through the fabric!”

Conceptually, the learner must move through pre-operational conceptual understanding to concrete conceptual understanding in order to have enough flexibility of language function to adapt their use of language for new circumstances. In addition, in order to have the use of displacement as a function of language, the learner must reach at least a concrete level of conceptual understanding to comprehend times and places displaced from the here and now. When the instructor shares a personal “I”
story, the student can begin the learning process of to conceptualizing places and experiences outside of themselves.

After the teacher has shared a preoperational story, the students were asked to do the same. When the students have described their own preoperational experience/story, through drawing or writing, the learners can share their stories with each other. Drawing and telling a story allows the learner to opportunity to use their language productively, in a social setting, while also learning the stories of others. Learners move from preoperational conceptualization with their own experience, to concrete conceptualization as they hear and see the experiences of others. In this way, there are multiple points of access for learners because they are able to make unique neural connections depending on where the information connects to existing neural circuits, possible strengthening those connections into neural networks. When used as part of a creating connections to a larger body of conceptual knowledge, the preoperational story experience also give the learner the opportunity to demonstrate knowledge from the very beginning, becoming part of a learning community of practice. The growth chart from this year gives more information about the efficacy of practices based upon the NLLT.
Figure 4.15. Year four pre-test/post-test student growth data.

This year, 66% of students exceeded end of year standards in reading, up from 52% the year before. Of note for the past three years of data, is that the students entering this learning environment at the beginning of the year are not all meeting reading standards. The students entering the class are students who were struggling to achieve growth in literacy before first grade, yet make growth during the nine months they are in first grade that brings them to first grade reading levels, or beyond. Seven students began the year at a Level Zero, meaning they did not pass the DRA level required for meeting kindergarten expectations at the end of kindergarten. A Level Zero indicates that a student has few measurable literacy skills and cannot identify any words on a page of text. Five of these students met or exceeded grade level, meaning they made two or more year of growth in one academic year of school, and two students ended the year at mid-first grade level, meaning they made one and a half years growth in one academic year. This data was very encouraging for the teacher, so more learning strategies were added for year five.
Year Five

In addition to the previous strategies, two more strategies were discussed and added to the classroom. The first strategy had the students ask the questions *why* and *how* in all content areas. The acquisition and purpose of language begins with the concept of *why* and *how* because language is purposeful by its very nature.

When a learner proposes a statement such as “I went to the park”, there is a lack of deep structure represented because the statement lacks propositions, which also reflect semantic specificity. However, if the learner is asked *why* and *how*, and the learner answers those questions, the statement becomes semantically expanded. Now the statement might read, “I rode to the park on my bike because I wanted to swing on the tire swing.” Notice the expansion and clarification of thought and greater semanticity in the language. In addition, the larger meaning of the statement is refined so that there is less ambiguity for the reader.

The refinement of language mirrors the pruning of neural networks as new information entering the brain is either integrated into existing networks or inhibited in some regions and sent onto areas where more integration is needed. The brain will organize concepts into efficient networks by the refinement of meaning, therefore mirroring the refinement of language. Each time a learner clarifies their thinking by answering why or how, efficient neural connections are formed. This methodology was an important component in creating classroom language events. Many language theorists (Arwood, 1983; Bruner, 1975; Dewey, 1910; Halliday, 1977; Searle, 1970; Vygotsky, 1962) point to the search for answers as the driving force behind most
academic discoveries and the main purpose of language. The search for answers in the classroom setting begins with asking *why and how* and the events of the classroom exist to answer the questions, and the products of the events as the results of the answers. Vygotsky (1962) observed “…that a concept is not an isolated, ossified, changeless formation, but a active part of the intellectual process, constantly engaged in serving communication, understanding, and problem-solving” (p.53).

The second strategy was to use oral language in a way that would allow learners with visual cognition greater access to meaning. In the classroom setting, it is not always possible for the teacher to draw all expectations and concepts. However, it is possible to add more contextual information to spoken English. For example, the teacher could say, *get ready for math.* This statement is very low context because there are multiple interpretations possible for the listener. The word *get* could mean pick up or join, the word *ready* could mean different things in different context; does the speaker mean physically ready, mentally ready, and really, what does *ready* look like? Even the concepts behind the word *math*; is math a thought, a workbook, a discussion, a practice sheet? For the visual thinker, the low context nature of the acoustic statement, *get ready for math,* leaves the acoustic words at a pattern level. Such a statement does not form a complete, clear picture of its meaning for a learner using visual cognition to perceive and process information.

In order to give oral language high context, the teacher connected multiple ideas about the situation. Additionally the teacher included how the expectations specifically look (what are hands and feet doing) and the agency relationships within
the context. For example, instead of saying, “Let’s get ready for P.E.”, the teacher would say, “Boys and girls, please put away your books, pencils and other tools you were using where they belong because Mr. Smith is waiting for us in the gym. He is waiting for us because he wants to help you get some exercise and learn a new game, so please put away all of your learning tools so we can line up and walk to the gym to see Mr. Smith.”

When the learner begins to see the relationships among agents, actions, and objects, they begin to layer to concepts to allow their language flexibility. The maximum flexibility of language allows the listener to infer the meaning of low-context situations in order to act upon them in a socially appropriate manner.

Therefore, this practice both describes language and encourages language acquisition as meaning is clarified in way that is accessible to learners with a visual thinking system.

Figure 4.16. Year five pre-test/post-test student growth data.
As shown in Figure 4.16, 60% of students exceeding reading standards for first grade. Eight students were below grade level entering first grade, with seven of those students making one to two years growth during the academic year and one making a single year growth. Once again, although 36% started below grade level in September, only 5% were below grade level in the fall.

The first grade teacher continued to use the previously described strategies for across multiple contexts throughout the classroom day. There was one more key strategy added and refined over years six through nine known as a concept language flowchart. As the learner acquires layers of concrete language experiences, it is possible to connect multiple concrete concepts to create a formal understanding of a displaced concept. Formal concepts, such as health, respect, honest, or justice, cannot be seen or felt. Formal concepts require maximum displacement, semanticity, flexibility and productivity to fully understand and use with natural language in multiple settings, and is represented by innumerable pathways in the brain connecting neural networks of language.

In the classroom, the teacher assisted young learners in making those connections using a concept flowchart. The ability for the young learner to use language to represent formal concepts is critical step towards critical thinking, problem solving, and understanding the needs of others. Drawing a concept flowchart with young learners was an important classroom practice to help them make the conceptual leap from concrete to formal language.
The data for years six through nine will be displayed without further explanation of classroom methods influencing the learning of the students because the previously mentioned methods continued to be used and refined. The teacher did not teach using discrete literacy sub-skills or any published reading curricula during the time any of the data was recorded.

**Year Six**

![Figure 4.17. Year six pre-test/post-test student growth data.](image)

This year most students had met the kindergarten reading benchmark and by the end of the year, all students were at benchmark in reading. This year had less *clear and intact* students than any other data collection year.

**Year Seven**

This year, 73% of students exceeded grade level standards for reading. The two students who did not meet grade level standards made one year's growth, beginning the year below kindergarten level and ending above kindergarten benchmark. Both students also had Individual Education Plans in effect from kindergarten.
Figure 4.18. Year seven pre-test/post-test student growth data.

Year Eight

Figure 4.19. Year eight pre-test/post-test student growth data

The data this year shows 68% *exceeding* reading standards with only one student not achieving end of year reading standards for first grade, but the student did make one year of reading growth.

Year Nine

As teacher continued to use a refine the methods aligned with the NLLT, aligned with the theoretical frameworks of neuroeducation, the results for literacy achievement in the classroom environment are very similar. There are 72% of students
exceeding grade level benchmark, with ten students showing two or more years growth on the assessment during the academic year. The student who did not achieve end of first grade goals made one year of growth as evidenced by the DRA.

*Figure 4.20. Year nine pre-test/post-test student growth data.*

The final figure in this chapter provides summative data for each year of the data collection. From years three through nine, there are more student in the exceeding category than in the meet and not meet combined. By year five, less than 10% or students overall did not meet literacy benchmarks.

*Figure 4.21. Final summative results of nine years of literacy data.*
Conclusion

The purpose of the section was to give the reader a practical and theoretical description of classroom methods aligned to neuroeducation with evidence of their effects on student learning. The first section provided Figure 4.1, determining current operational tenets regarding teaching and learning, with theoretical basis, and the manifestation of the tenet in classroom practice. The next section provided a similar table with a proposed paradigm shift representing neuroeducation and the classroom practices that arise from the theoretical frameworks defined in Figures 4.2, 4.3, and 4.4. The next figure displayed the direct alignment between the current operational tenets and the proposed neuroeducation tenets.

The third section coded the transcription of classroom interactions taken from language events reflecting neuroeducation. The coding found strong evidence for the use of the underlying features of language function, deep language structure, and neurocognitive psychology during the classroom language event. Finally, historical literacy data from a classroom environment utilized neuroeducation practices provided evidence of consistent growth in achievement data over nine years. After year five, 90% or more students were achieving proficiency on district literacy benchmarks each year. All students were found to have made at least one year of growth, with 50% or more making two years or more growth as measured by the district mandated assessment. Chapter Five concludes this research with implications for future curricula design, theoretical models, teacher preparation programs, and ongoing teacher education based upon the findings of this research.
CHAPTER FIVE
DISCUSSION

The purpose of this study was to propose an alignment between research reported in the literature on language acquisition and language function, and how that research is represented in current literacy (reading, writing, speaking, listening, viewing, thinking, calculating) practices in order to develop and recommend a paradigm shift in classroom learning practices aligned with the Arwood Neuroeducation conceptual framework. Arwood’s Neuroeducation model overlaps literature from cognitive psychology, language theory, and neuroscience. This model of neuroeducation is unique in its consideration of language acquisition and function upon the learning process.

Figure 5.1. Arwood’s neuroeducation model.
In order to propose an alignment to this neuroeducation model, four research questions were considered in this study:

1. What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice?

2. What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment?

3. How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy?

4. Can literacy data, collected from a classroom environment based upon language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift?

Overall, the outcomes of this study were to identify what theories of learning influence tenets in education today, how those tenets shift when matched to the literature, how the new tenets can be identified in a neuroeducation based classroom, and the effectiveness of classroom practices based upon a paradigm shift to a
neuroeducation based classroom. The purpose of this chapter is to discuss and interpret the results of the four research questions addressed in this study with possible implications and suggestions for future work. The chapter will be organized into four sections in order to address each research question.

**Analysis of Current Paradigm Influencing Teaching and Learning**

“*Listeners or readers do not have meanings poured into them – they are not conducted to them directly through the sounds in the air or from the marks on the paper; they make them from what is linguistically given in relationship to all that constitutes their own self-awareness*” (Holdaway, 1979, p. 153).

In Chapter Four, Figure 4.1, Analysis of Tenets within Current Paradigm Influencing Teaching and Learning, was provided to show the results for the analysis of research question one: What are the accepted tenets within the current operational paradigm surrounding teaching and learning; what theoretical frameworks does the literature suggest support the currently accepted tenets, and how do the tenets manifest in commonly accepted classroom practice? The figure was designed to allow the reader to ascertain the underlying theoretical frameworks influencing teaching and learning in the current school culture. Often, certain aspects of a culture are so deeply ingrained that they are no longer questioned. Figure 4.1 provides a framework for identifying instructional practices, the underlying beliefs influencing those practices, and the theoretical frameworks influencing the beliefs. Chapter Two provided an overview of history of schooling in the United States, delineating the cultural shifts of the postmodern era, which led to many of the tenets identified in Figure 4.1. Chapter Two also provided context for tenets within the current paradigm chosen for Figure 4.1; input-output model, reductionist model, deficit based model, Theory of Mind, and
product based learning. There appears to be a consistent theoretical basis for the six identified tenets influencing curricula and instructional choices within the dominant educational structure.

The Analysis of Tenets within Current Paradigm Influencing Teaching and Learning provides a concise analysis of the information presented in Chapter Two. In Figure 4.1, the theoretical framework of Western Psychology was identified as an underlying theoretical framework in three; Theory of Mind, deficit based intervention, and input/output teaching, of the six areas. Theories underlying principles of Western Psychology include the study of behavior to determine the working of the mind, such as memory, perception, problem solving, and attention (Anderson, 2010; Craik, 2002; Estes, 1967; Greene, 1985). This is closely related to cognitive psychology, which utilizes behavior and neuroscience data to determine the workings of the mind (Anderson, 2010; C. G. Lucas et al., 2014; Reisberg, 2013; St Clair-Thompson & Gathercole, 2006). In the figure under discussion, cognitive psychology was determined to be an underlying theoretical framework for the tenets reductionist teaching, Theory of Mind, and products as learning. Finally, behaviorism utilizes the interpretation and control of observable behaviors to reinforce and control the information presented to the learner. Programmed, repeated behavior represents learning in this model (Anderson, 2010; Estes, 1967; Kozol, 2005b; Skinner, 1953). Behaviorism was found to be an influencing theoretical framework for input/output teaching, reductionist teaching, deficit-based intervention, and imitated and replicable products as evidence of learning.
The pervasive use of educational practices designed with these underlying tenets (Cochran-Smith & Lytle, 2006; Rothstein, 2008; Spencer, 2009; Stillman & Anderson, 2011; Sunderman, Tracey, Kim, & Orfield, 2004) demonstrate how deeply ingrained the aforementioned theoretical frameworks are in the current educational culture. Some examples of these educational practices include: predetermined learning outcomes, oral presentations of information, imitation and replication of information, standardized curriculum, isolated sounds for spelling and reading, scope and sequence lesson design, double dose intervention using the same instructional methods, vocabulary and spelling lists, flash cards, and diagnostic labels based upon student weaknesses. Such practices are standard in schools today; however, there is little discussion or acknowledgement of the theories underlying the practices, possibly because they have been such a pervasive part of the educational culture for so long that they are no longer questioned. This study provided the analysis of current practices because there appears to be a gap in the literature regarding a discussion of the underlying assumptions regarding teaching and learning in the dominant paradigm and how those assumptions affect decision making regarding curriculum design and instruction.

If the current educational practices for helping learners acquire literacy processes were widely effective, there would be little need for discussion. However, since only 40% of fourth graders nation-wide demonstrating proficiency in math and reading on the National Assessment of Educational Progress (NAEP) (National Center for Education Statistics & Hager Sharp, 2013) and with minimal evidence of a positive
effect on reading achievement after ten years of No Child Left Behind (Allington, 2002; Dee & Jacob, 2011; Rothstein, 2008) policies aligning to the dominant paradigm, it may be reasonable to begin to question the status quo. 

The theoretical frameworks underlying current tenets of learning represent the same basic principles; assumptions regarding learning, perception, memory, and thinking based upon observable behavior interpreted through dominant paradigm. It is possible that with only behaviorism, cognitive psychology and psychology theories underlying practices, the educational community has a restricted view of the complexities of the learning process. Understanding the impact of language acquisition and relevant principles of neuroscience on the learning process may reveal a deeper picture for the process of learning. In order to fully explore and explain the scope of human learning, there may need to be a consideration of more theoretical frameworks that could impact classroom practices. The search for a deeper understanding of the learning process that impacts classroom practices leads to a discussion of research question two.

### Analysis of New Tenets: A Neuroeducation Paradigm

“New opinions are always suspected, and usually opposed, without any other reason but because they are not common” Locke (1841).

The purpose of this section is to address the results of the following research question: What new tenets regarding the acquisition of literacy processes (reading, writing, thinking, speaking, listening, and calculating) can be identified through the literature aligned with neuroeducation conceptual frameworks? What classroom learning practices for literacy processes manifest from this alignment? The previous
section clarified the current paradigm, revealing a narrow conceptual and theoretical framework for understanding the complex process of learning influencing classroom practices. Clearly, there is a need for a new way of triangulating the existing literature regarding learning by providing an overlap of language theory, neuroscience, and cognitive psychology representing neuroeducation. This study bridges a gap in the literature regarding the acquisition of literacy processes (reading, writing, thinking, speaking, viewing, listening, and calculating) by providing the connections between language, learning, and literacy.

Tenets representing a neuroeducation paradigm shift considers the literature regarding language acquisition and neuroscience upon the process of learning. Underlying each one of these tenets are multiple considerations of language theory and neuroscience; their theoretical overlap translates cognitive psychology and neuroscience into effective practices.

**Learning as a Conceptual Process**

“...a concept is more than the sum of certain associative bonds formed by memory, more than a mere mental habit; it is a complex and genuine act of thought that cannot be taught by drilling...” (Vygotsky, 1962, p.82)

Learning as a conceptual process is supported by many researchers in the field of language theory (Arwood, 2011; Bruner, 1975; Carroll, 1964; Halliday, 1977; Peirce, 1878; Vygotsky, 1962), which has also been confirmed by neuroscientists studying the process of concept acquisition on the neurobiological level (Damasio & Geschwind, 1984; Lenneberg, 1969; Poeppel et al., 2012; Pulvermuller, 2013a), providing an overlap with works on concept development by cognitive psychologists.
(Chomsky, 1968; Piaget, Cook, & Norton, 1952). Although much evidence in the literature supports learning as a conceptual process, current classroom practices emphasize repetition, copying, matching surface patterns, or using products derived from teacher created materials, which do not support conceptual learning. And, given the need for students to learn concepts in the way they think, without classroom practices emphasizing the opportunity for learners to use their own thinking then these current practices may not provide the best opportunities for all learners to access education.

<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
</table>
**Neurosemantic Language Learning Theory:** learning is a dynamic process between the language user, meaningful sensory input, and the outside user of language helping name the input. Multiple overlapping patterns form concepts; through layers of concepts the learner acquires language. (Arwood, 1983, 2011)  
**Neuroscience:** the structures of the brain are acquired through the acquisition of language which represents concepts. Structures acquired through the use of the learning system semantically develop language and facilitate the acquisition of wide-spread neural networks allowing for process of inhibition/integration of new information, increasing neural networks through stages of conceptual layers. (Damasio & Geschwind, 1984; Lenneberg, 1969; Poeppel et al., 2012; Pulvermüller, 2012; Pulvermüller, 2003) | Preoperational Stories.  
Event based learning.  
Visual Concept Dictionaries.  
Drawing before writing.  
Student created projects.  
Students using natural language to disseminate knowledge.  
Student products are unique- represent individual learning process. |

*Figure 5.2. Analysis of tenets representing a neuroeducation paradigm shift.*
From the literature, a paradigm shift to utilizing neuroeducation-based classroom practices appears to be a better match with the literature than current practices. The classroom practices that emerge from neuroeducation acknowledge learning, as a process, include: event based learning, visual concept dictionaries, drawing as part of the writing process, student created projects that represent unique concepts, and student production of natural language to disseminate knowledge. Figure 5.3 demonstrates how the underlying conceptual frameworks of the tenet learning as a conceptual process align with the neuroeducation model and how the tenet manifests in classroom practice.

*Figure 5.3. Learning as a conceptual process.*
Learning as a Function of the Whole

“Instead of thinking of language as a collection of separate traits, one comes to see it as a profoundly integrated activity. Language is also to be understood as an operation rather than a static product of the mind. Its modus operandi reflects that of human cognition because language is an intimate part of cognition” (Lenneberg, 1969, p.164).

Next, the tenet regarding learning as a function of the whole is supported by literature across multiple theoretical fields. Experts in language acquisition and language function agree that the surface structure of language exists because of the deeper meaning of the whole concept exists (Arwood, 2011; Bruner, 1975; Carroll, 1964; Dewey, 1910; Halliday, 1977; Searle, 1970; Vygotsky, 1962; Whorf, 1944). Pragmaticism clearly states that the whole is greater than the sum of its parts (Arwood, 1983; Peirce, 1878; Zeman, 1977). Psycholinguists emphasize that the acquisition of literacy processes occurs when the whole meaning of a concept has been acquired. (Clark, 1977; Clark, 1978; Holdaway, 1979; Smith, 1999; Smith & Goodman, 2008). Neuroscientists are finding evidence that language is processed through multiple neural networks throughout the brain, representing the synergy of the whole brain functioning together (Arsenault & Buchsbaum, 2015; Gallistel & Matzel, 2013; Geake, 2004; Hruby & Goswami, 2011; Mohr et al., 1996; Pulvermüller, 2005).

Although reductionist methods are pervasive in the current educational culture, there are researchers who question the efficacy of reductionism for teaching and learning (Foster, 2013; McLeod, 2008; Newkirk, 2009; Poplin, 1988).
<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function of the Whole</td>
<td><strong>Language Theory:</strong> the structure (parts) of oral language represents conceptual acquisition of a whole idea. Only with the acquisition of a whole concept can the parts (structure) be identified or utilized in a conventional way. (Arwood, 2011; Carroll, 1964; Dewey, 1910; Halliday, 1977; Sapir, 1949; Searle, 1970; Vygotsky, 1962; Whorf, 1944) <strong>Pragmatism:</strong> the whole is greater than the sum of the parts. The functional use of language represents a deep understanding of layers interconnected semantic relationships. As concepts are acquired, they become symbolized between agents to form conventional language. (Arwood, 1983; Peirce, 1878, 1902; Zeman, 1977) <strong>Psycholinguistics:</strong> Only with the whole meaning of a concept can the literacy process of reading occur because the underlying function of the concepts allow access to the structure of language represented in text. (Clark, 1977; Clark, 1978; Holdaway, 1979; Smith, 1999; Smith &amp; Goodman, 2008) <strong>Neuroscience:</strong> Language is represented neurobiologically by neural networks using many regions and relay stations of the brain; brain function represents a synergy between different areas of the whole brain. (Arsenault &amp; Buchsbaum, 2015; Gallistel &amp; Matzel, 2013; Geake, 2004; Hruby &amp; Goswami, 2011; Mohr et al., 1996; Pulvermüller, 2005)</td>
<td>Visual flowcharts – see how the concepts are interconnected. Reading is taking ideas from the page-the whole idea greater than the component parts. Writing is showing ideas- use how a whole word looks to write the idea – visual concept dictionaries. Drawing before writing allows the reader to see the whole idea. Asking why and how- answering the big questions. Classroom learning events- layer conceptual meaning to acquire function in the frontal lobe for formal thinking.</td>
</tr>
</tbody>
</table>

*Figure 5.4. Analysis of tenets representing a neuroeducation paradigm shift.*

With such compelling evidence from the literature regarding the importance of the function of the whole, a need for a paradigm shift to better match the literature base seems evident. Figure 5.4 provides a connection between neuroeducation and the identification how the tenet The Function of the Whole aligns to neuroeducation.
Using the translation of the literature helps shifts thinking about educational practices away from teaching small units of meaning to emphasizing larger unit units of meaning to create larger meaning. Instead of the teaching of the small units decided by the teacher or determined by published curricula, classroom practices such as visual flowcharts allow students to see how concepts interconnect, ways to see the whole idea to read and write, and prompts to inquiry for authentic problem solving in the classroom. These methods better match with what the literature reports about learning, language, and literacy and represent a shift towards giving learners a chance to use the semiotic nature of language within a synergistic brain in order to see the big picture of
the whole instead of random small pieces of information which have been predetermined by an adult as the way to create meaningful literacy processes.

**Semantic Learning Model**

“...learning to use a word in a meaningful way implies that the child has acquired the concept which underlies the linguistic response” (Carroll, 1963, p. 90).

The final tenet resulting from literature is identified as a semantic learning model; a meaning based learning model. Semantic learning means that input is received in a way that is neurobiologically meaningful in order for conceptual learning to occur.

<table>
<thead>
<tr>
<th>Tenet representing a neuroeducation paradigm shift</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Learning Model</strong></td>
<td><strong>Language theory</strong>: learners use the concepts they begin to acquire new concepts by forming semantic relationship between a known idea and an unknown idea. (Carroll, 1964; Halliday, 1977; Hymes, 1964; Lucas, 1980; Peirce, 1878; Tomasello, 2003; Vygotsky, 1962) <strong>Neuroscience</strong>: the brain will create efficient pathways through inhibition and integration of sensory information using the strength of the neural structures; will rewire around neural structures that do not provide strong feedback for integration/inhibition of new sensory information. (Baars, 2010; Bassett et al., 2011; Doidge, 2007; Gage &amp; Muotri, 2012; Laszlo &amp; Sacchi, 2015; Park &amp; Huang, 2010)</td>
<td>Classroom learning events allow for multiple points of access; neurobiologically multi-modal, and multiple levels of conceptualization. Finding the neurobiological strength of the learner to develop individual strategies for concept acquisition. See the whole child as a learner instead of separate diagnosis to be addressed</td>
</tr>
</tbody>
</table>

*Figure 5.6. Analysis of tenets representing a neuroeducation paradigm shift.*

There is an agreement among language theorists that learners use the concepts they have acquired to learn new concepts by forming semantic relationships between a known idea and an unknown idea (Bruner, 1975; Carroll, 1964; Halliday, 1977; Hymes, 1964; Peirce, 1878; Tomasello, 2003; Vygotsky, 1962). Recent neuroscience research is finding that the brain creates efficient pathways for new information using
the strength of neural structures and these pathways will rewire around neural structures that do not provide strong feedback of new sensory information (Baars, 2010; Bassett et al., 2011; Doidge, 2007; Gage & Muotri, 2012; Laszlo & Sacchi, 2015; Park & Huang, 2010). The brain uses what is meaningful to strengthen and prune neural structure and language is acquired as meaningful information that can connect to already acquired concepts. In this way, a semantic (meaning) based learning model is also a strength-based model. The alignment of The Semantic Learning Model within the neuroeducation theoretical frameworks is provided in Figure 5.7.

Figure 5.7. Semantic learning model.
In order to allow all learners to acquire literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating), classroom practice must shift to allow multiple neurobiological and conceptual points of access to meaning. Intervention would need to shift from finding the deficit in a learner and fixing it, to finding the strength of a learner and building upon it. Instead of a diagnostic label identifying what literacy processes the learner has difficulty achieving, the focus should be on the strengths of the learner. The strengths of the learner represent what is meaningful to the learner, which aligns with a semantic learning model.

The figures providing tenets representing a neuroeducation paradigm shift proves a bridge between the theoretical and the practical as this study develops a classroom model for a practices aligned to neuroeducation. The overlap of neuroscience, language theory, and cognitive psychology provides the basis for the evolution of tenets representing a paradigm shift. For each tenet, classroom practices emerge that represent the educational applications of theory derived from the literature base supporting neuroeducation. The identification of tenets aligning to the neuroeducation theoretical frameworks that aligned to effective classroom practices allows this research to fill a gap in the literature.
Neuroeducation Learning Events

“A word without meaning is an empty sound, no longer a part of human speech. Since word meaning is both thought and speech, we find in it the unit of verbal thought we are looking for. Clearly then, thought is semantic analysis – the study of the development, the functioning and structure of this unit, which contains thought and speech interrelated” (Vygotsky, 1962, p.5).

In the previous section, there was a connection made between the tenets of neuroeducation and classroom practices aligning with neuroeducation. The application of theory to practice is a natural progression in the paradigm shift from teaching to learning as the educator acknowledges the neurobiological learning system of the student by matching classroom practices with each student’s neurobiological learning system. This discussion addresses the following research question: How do literacy processes (reading, writing, thinking, speaking, listening, viewing, and calculating) identified in an elementary, urban classroom engaged in language acquisition events align with a neuroeducation approach to literacy?

If classroom methods for the acquisition of literacy processes align with a neuroeducation framework, there would be evidence of features underlying the theoretical frameworks in the application of classroom practice. This research found strong evidence for elements of language theory and neurocognitive psychology throughout the transcribed learning events in the classroom.
<table>
<thead>
<tr>
<th>Neuroeducation tenet</th>
<th>Theoretical framework supporting tenet</th>
<th>Manifestation in classroom instructional practices</th>
</tr>
</thead>
</table>
| Learning as Conceptual Process | Social Constructivism  
Language Theory  
Neurosemantic Language Learning Theory  
Neuroscience | • Preoperational Stories  
• Event based learning  
• Visual Concept Dictionaries  
• Drawing before writing  
• Student created projects  
• Students using natural language to disseminate knowledge  
• Student products are unique- represent individual learning process |
| Semantic Learning Model | Language Theory  
Neuroscience | • Classroom learning events allow for multiple points of access- neurobiologically multi-modal, and multiple levels of conceptualization.  
• Finding the neurobiological strength of the learner to develop individual strategies for concept acquisition  
• See the whole child as a learner instead of multiple diagnosis |
| Function of the Whole | Language Theory  
Pragmaticism  
Psycholinguistics  
Neuroscience | • Visual flowcharts – see how the concepts are interconnected  
• Reading is taking ideas from the page- the whole idea greater than the component parts  
• Writing is showing ideas- use how a whole word looks to write the idea – visual concept dictionaries  
• Drawing before writing allows the reader to see the whole idea  
• Asking why and how- answering the big questions  
• Classroom learning events- layer conceptual meaning to acquire function in the frontal lobe for formal thinking |

*Figure 5.8. Classroom methods representing a neuroeducation paradigm shift.*

Data coding described in Chapter Two revealed consistent use of elements of language deep structure, language function, and neurocognitive psychology by the teacher. In each lesson, evidence of alignment with the neuroeducation framework occurred twice a minute during thirty minutes of a learning event in the classroom.

*The Frequency Analysis of Theoretical Frameworks Coded from Classroom*
*Neuroeducation Learning Events* provide evidence to indicate that students in a neuroeducation learning environment were given the opportunity to acquire stronger language function throughout their interactions with the teacher. For future research, there may be value in applying the coding parameters to measure the frequency of elements of neuroeducation in a classroom not currently working within the neuroeducation paradigm. Then a comparison could be made between learning environments based upon different paradigms.

The current body of literature provides multiple examples (Heath et al., 2014; Hoff, 2003; Kuhn, Willoughby, Wilbourn, Vernon-Feagans, & Blair, 2014; Pascalem et al., 2014; Skoe et al., 2013; Smith & Goodman, 2008; Wamba, 2010) of the strong connection between language function and the acquisition of literacy processes (reading, writing, thinking, viewing, listening, speaking, and calculating). Harlaar et al. (2008), Hayiou-Thomas et al. (2010), Hart (1995) and Dickinson and Porche (2011) are just a few of the researchers who have found consistent connections between language function in young children and later success in the acquisition of literacy processes. Therefore, it is reasonable to assume that a classroom environment focused upon the acquisition of language would result in students who more capably acquire literacy processes. If the neurobiological learning system of the learner is also acknowledged, thereby helping the child create conceptual meaning from the perceptual patterns, then all learners would demonstrate growth in the acquisition of literacy processes as their functional language improved.
The seminal research provided by Hart (1995) on the connection between language function and later academic gains gave multiple examples of interventions used to help all children gain the functional language they needed to acquire literacy processes, but Hart’s research found insignificant evidence of an overall increase in language function. Examination of Hart’s research using the lens of neuroeducation revealed that the interventions were focused on the surface structures of language, such as using more verbs or nouns, or increasing the greater overall frequency of utterances. The literature regarding language provides an explanation for why teaching of the surface structures of language did not increase overall language function. It is the deep structure of language (Carroll, 1964; Peirce, 1902), formed through the acquisition of concepts (Vygotsky, 1962) that underlies the surface structures noted by Hart. Instruction that focuses solely on the use of surface structures will not provide the acquisition of concepts needed to form the deep structure of language. Without the deep structure of language (semantic relationships, expansion, extension, and modulation) representing concept acquisition, surface forms of language are restricted, therefore language function (displacement, semanticity, productivity, flexibility, efficiency) is restricted and the acquisition of literacy processes is considerably affected. The low acquisition of language function by overemphasis on teaching surface structures may also explain the low national achievement rates on the NAEP. Research has identified children with diagnosed learning differences (e.g. autism, ADHD, Downs Syndrome) (Getahun et al., 2013; Mitka, 2010; Nash et al., 2013; Zampini & D'Odorico, 2013), children learning English as a second language...
(Arwood & Robb, 2008; Zwiers et al., 2013), and children living in generational poverty (Hart, 1995; Hemphill & Tivnan, 2008; Judge, 2013) with lower functional language than their peers. Given the connection between language function and literacy, it is likely these groups also struggle with the acquisition of literacy processes because classrooms overemphasize instruction in the surface structures of language. Perhaps in a learning environment based the use of functional language for the acquisition of concepts would help children from all of these groups achieve academic parity with their peers.

This study helps fill a gap in the literature because although researchers have noted the importance of language function on later academic achievement, they have not demonstrated the connection between language function versus language structures and their effect of later academic achievement. There is also limited data available in the current literature to determine that methodologies, provided in this study, may improve language function for greater frequency of acquisition of literacy processes for all learners.

The next section of this chapter is a discussion of historical literacy data from a learning environment that had changed from the dominant teaching paradigm to a neuroeducation paradigm. If the acquisition of language occurs from learning layers of concepts over time, and if functional language acquisition is critical for the acquisition of literacy processes; then the literacy data should reveal steady growth in the achievement of all students in a neuroeducation based learning environment.
Historical Literacy Data

“...the teacher should rid himself of the notion that “thinking” is a single unalterable faculty; that he should recognize that it is a term denoting the various ways in which things acquire significance” (Dewey, 1910, p.39).

The purpose of this section of the study was to address the following research question: Can literacy data, collected from a classroom environment based upon the literature earlier reported about language acquisition and function, provide evidence for the effectiveness of the tenets represented by a neuroeducation paradigm shift? This study provides Figure 5.9 in order to show the overall results of a learning environment that had undergone a profound paradigm shift. By year three in this learning environment, the tenets of neuroeducation were consistently applied in classroom instructional practices.

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>NotMeet</td>
<td>42%</td>
<td>12%</td>
<td>9%</td>
<td>11%</td>
<td>5%</td>
<td>0%</td>
<td>9%</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>Meet</td>
<td>16%</td>
<td>50%</td>
<td>39%</td>
<td>22%</td>
<td>36%</td>
<td>43%</td>
<td>18%</td>
<td>27%</td>
<td>24%</td>
</tr>
<tr>
<td>Exceed</td>
<td>42%</td>
<td>37%</td>
<td>52%</td>
<td>67%</td>
<td>59%</td>
<td>57%</td>
<td>73%</td>
<td>68%</td>
<td>72%</td>
</tr>
</tbody>
</table>

Figure 5.9. Summative DRA results by year.

The students across these nine years were mainly students living in poverty (65%-85%) and students learning English as a second language (30%), which traditionally are groups of student who do not make large gains in the acquisition of
literacy processes. However, in a learning environment emphasizing meaningful, process-based, concept acquisition, all of the learners demonstrated consistently high levels of achievement. Consider that after year two, 50% or more were exceeding the grade level expectations, which means they were reading at least one year above the required end of year score. Although not used for this study, the researcher has also collected language samples from students throughout the nine years to analyze for growth in language function. The analysis used to evaluate growth with language samples was similar to the analysis described in this study. The language samples aligned with the summative DRA results; children who showed improved functional language also saw growth in their acquisition of literacy processes (Arwood & Robb, 2008).

This data confirms what the triangulation of literature underlying the neuroeducation model (Arwood, 2011); language theory (Halliday, 1977; Peirce, 1902; Tomasello, 2003; Vygotsky, 1962), neuroscience (Lenneberg, 1967; Poeppel et al., 2012; Pulvermüller, 2003), and cognitive psychology (Piaget, 1959) (Anderson, 2010) suggests; that a classroom environment that uses this approach performs better than on that does not. When a learning environment is designed with these neuroeducation tenets in place, the literature suggests that all students can and will learn using the strength of their own neurobiological learning system. However, if a teaching environment asks students to learn in a way that is not aligned with their neurobiological learning system, then fewer children may find success in the
acquisition of literacy processes (Dee & Jacob, 2011; Finn et al., 2014; National Center for Education Statistics & Hager Sharp, 2013).

**Implications and Suggestions**

“By concentrating in the past on the exclusiveness of literacy tasks even from each other we have undervalued the fundamental process of all language...we need to remember that anything that can be said of human language and language learning has some vital bearing upon the processes of literacy” (Holdaway, 1979, p.13).

The current educational system is not meeting the learning needs of all students as evidenced by the NAEP. If only 40% of students are proficient in reading and math, then the system is not allowing all students access to literacy processes. There is an important distinction between the system and individual teachers. There are incidences of greatness, of wonderful teachers helping students in amazing ways. However, the system as a whole is set up in a way that makes sustaining and replicating moments of greatness difficult because the current paradigm is predicated on learning practices that do not match the way the brain receives and uses information or how language function is used and acquired.

Teachers are working hard to help children learn, but perhaps do not have the knowledge of neuroscience and language theory needed to help children use their own neurobiological learning systems. When this researcher informally asks teachers what they know about how the brain receives and processes information, they express that they have received no formal education about neuroscience. A search of teacher education programs at one public and four private colleges in one large metro area showed that in 2016, there were no classes devoted to how the brain functions: neuroscience.
Given that all children have a brain and that there is a plethora of neuroscience data available regarding learning, perhaps is it time to require the neuroscience of learning as part of all undergraduate teacher education programs. A basic understanding how the brain receives and processes information at a physical level could help teachers design learning environments that will allow more children access to literacy processes. In addition, many professional educators (Ferrari, 2011; Fischer et al., 2010; Geake, 2004; Geake & Cooper, 2003; Immordino-Yang, 2011a; Mason, 2009; Purdy & Morrison, 2009) are looking to incorporate neuroscience principles into their classroom, but perhaps because they do not have the knowledge base to examine neuroscience research, teachers rely on others’ interpretations of neuroscience applied to classroom learning (Carew & Magsamen, 2010; Christodoulou & Gaab, 2009; Ferrari, 2011; Fischer, 2009). Given that the current paradigm of teaching and learning is influenced by tenets steeped in behaviorism and principles of cognitive psychology, often the interpretations of neuroscience to classroom practice do not include the impact that language acquisition and function have upon the brain.

Arwood’s neuroeducation model is the only model that considers language theory in the translation of neuroeducation to classroom practices (Fischer et al., 2010; Geake, 2004; Geake & Cooper, 2003; Immordino-Yang, 2011a). This research adds a new perspective to the educational field by consolidating research on language theory, neuroscience, and cognitive psychology needed for construct validity in the emerging field of neuroeducation. Researchers have demonstrated a clear connection between
language function and the acquisition of literacy processes (Dickinson & Porche, 2011; Harlaar et al., 2008; Hart, 1995; Hayiou-Thomas et al., 2010; Heath et al., 2014) so perhaps teacher education programs should consider coursework on language theory as critical for understanding the learning processes. A search of teacher education programs at one public and four private colleges in one large metro area showed that in 2016, there were no classes offered that focused on the function of language. Descriptions of linguistics courses, typically only required for a specialty in teaching second language learners, show a focus on the structure of language, not the function. Teacher education programs should consider the brain, language, and the mind when choosing how to prepare teachers for working with children.

**Conclusion**

Change is never easy; change requires time, an open mind, ability to learn, adapt, try, and make mistakes. This research is asking educators to question the very foundations of the system that is dictating methods, curriculum, and assessment; but, until someone asks the questions, change will not occur. A shift in thinking from the current paradigm of teaching to a new paradigm based upon how students learn is needed. Some have been suggesting change is needed (Murnane et al., 2012; Zwiers et al., 2013) with the adoption of national Common Core Standards that call for students to understand concepts in depth through the acquisition of literacy processes. Other researchers have reminded the education profession that all children have the legal right to access learning (Hurder, 1997; Kozol, 2005a; Rebell, 2012; Rioux & Pinto,
suggesting that education professionals may need to be willing to adapt to meet the needs of the students they are charged with educating.

Change is never easy; but this research is strongly suggesting that a change in thinking about teaching and learning is vital if all children deserve the right to learn. When the theoretical frameworks of neuroeducation are applied to classroom environments, all learners are given the opportunity to create, solve problems, all while thinking critically and deeply as they access and productively use all literacy processes (reading, writing, thinking, speaking, viewing, listening, and calculating). When all children have the opportunity to learn using their own neurobiological learning system, then all children have access to acquiring literacy processes. A parent once wrote to this researcher, stating, “My son came into school this year feeling behind, scared and sad…I can’t believe the boost in confidence he has about school after this year.” This researcher hopes that with the paradigm shift proposed by the study, no young learners will feel behind, scared and sad at school. When the educational paradigm changes from teachers teaching to learners learning, all children will be able to acquire language and literacy in their own best way.
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