12-2019

Principals' Perceptions of Brain-Based Learning

Tami Hudson Godman

PRINCIPALS' PERCEPTIONS OF BRAIN-BASED LEARNING

by Tami Hudson Godman

This dissertation has been read and approved as fulfilling the partial requirement for the Degree of Doctor of Education in Curriculum and Leadership.

Robert Waller, EdD
Chair

Jennifer L. Brown, PhD
Director, Doctoral Program in Education

Michael Richardson, EdD
Methodologist

Brian Tyo, PhD
Director, COEHP Graduate Studies

Christopher Garretson, EdD
Committee Member

Deirdre Greer, PhD
Dean, COEHP

PRINCIPALS' PERCEPTIONS OF BRAIN-BASED LEARNING

by

Tami Hudson Godman

A Dissertation
Submitted in Partial Fulfillment of the Requirements for
the Degree of Doctor of Education
in Curriculum and Leadership
(EDUCATIONAL LEADERSHIP)

Columbus State University
Columbus, GA

December 2019

DEDICATION

I dedicate this dissertation to my family. Your ongoing support and love have made this degree possible. Thank you for enduring and walking through this process with me all while encouraging me along the way. I love you all very much!

ACKNOWLEDGEMENTS

Thank you to God, my family, friends, and my committee for your enduring support. Those nights when I felt I just could not type one more word, you encouraged me and guided me to keep going. My family listened, loved, and believed in me this entire adventure. My committee, especially my chair, Dr. Robert Waller, stayed in constant contact with me and kept pushing me to get to the next chapter. I am so fortunate and will forever be grateful to each of you!

ABSTRACT

The problem addressed by the study was a lack of research on principal's perceptions of brain-based learning and the potential impact on classroom instruction. The purpose of this study was to determine the association between the principal's perceptions of brain-based learning and instruction at their schools. The following research has been conducted using a qualitative paradigm. A case study involved a focus group of 12 principals and additional interviews with four of those principals. The qualitative data were thematically coded to provide information on patterns and practices within a variety of schools in the area. The findings offer the educational field insight on the impact principals' perceptions have on brain-based learning to improve student learning and teaching practices. The data collected support that a school principal's perception of brain-based learning directly affects the implementation of brain-based education in the school. School principals perceived brain-based learning activities as successful; implications are the continued use of brain-based learning in schools as well as professional development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The craft of teaching was once a much simpler field, but with Common Core standards, more rigorous expectations, and the demands of 21st century jobs, practitioners have begun preparing students for higher levels of learning and new types of jobs (Tokuhama-Espinosa, 2011). In education, these expectations represent continual changes that sway the thinking of educators and others. This process has been convoluted and overwhelming, which has required teachers and leaders to acquire skills and knowledge to achieve higher levels of student performance and learning (Wilson, Conyers, & Rose, 2015). One change has been the integration of mind, brain, and education science. Neuroscience research has provided scientific support for merging these fields (Hook & Farah, 2013). This new discipline has been influenced by emerging advances in technology and research involving how the brain learns (Tokuhama-Espinosa, 2011). Themes have emerged related to mind, brain, and education science that have directly affected the research-based methods and practices that practitioners use daily (Kwek, 2011).

Historically, the focus for educators was more on outward, measurable learning behaviors and knowledge than on the science of how people actually use their brains to learn (Hohnen & Murphy, 2016). Through the development of technology and an increase in the call for researchers to take a more prominent look at the brain and its functionality, more information has been collected and continues to develop (Tokuhama-

Espinosa, 2011). Ultimately, the aim of integrating education and neuroscience was to help students understand deeply, flourish, and ultimately become productive and contributive members of society (Ferrari, 2011). Technological enhancements have demonstrated the brain is remarkably adaptive and receptive (Aldrich, 2014).

The integration of mind, brain, and education science required an examination of the relationship between neuroscience, psychology, and education. This new discipline was founded as a transdisciplinary approach, which required practitioners to view the educational field in a different way (Tokuhama-Espinosa, 2011). Advances in the field of neuroscience have shown great promise to the educational community, but collaborations between these fields in the past have been few. The dissemination of learning of neural processes found in a laboratory must be applicable to learning in the classroom to be practically relevant (Dewhurst, Holmes, Brandt, & Dean, 2006). The debate between the laboratory and the classroom was relevant, and translating neural information into direct applications for the classroom continues to be of great importance (Hook & Farah, 2013).

Knowledge, as measured by behaviors reflecting mastery of learning outcomes, has been a measuring tool for schools and other institutions around the world. The academic view in which one sees, acquires, knows, and answers to demonstrate knowledge is at the heart of mind, brain, and education science. Modern education has required practitioners to embrace new challenges. This combined approach from mind, brain, and education science offers a new dimension of learning, and the relationship between these three fields encourages a new perspective. Education has acquired complex problems from society, rigor of standards, and advances in technology.

Students need to be able to synthesize information and to solve problems that traditional pedagogical practices alone cannot teach (Tokuhama-Espinosa, 2011). Larrison (2013) suggested that if a change were not made in the educational arena with curricular reform to meet individual and developmental needs of students, in 10 years the price would be astronomical for the U.S. educational system and would negatively affect students and their futures. One key element to this paradigm shift was to define a construct of mind, brain, and education science (Larrison, 2013). Ferrari and McBride (2011) suggested professional development specifically for teachers to facilitate and support the application of neuroscientific knowledge in classroom best practices. In addition, they proposed that knowledge or lack of knowledge of neuroscience research significantly impacted classroom practice (Ferrari & McBride, 2011).

Educators typically have little training in neuroscience (Ansari, Coch, & Smedt, 2011), due to the lack of knowledge about the field within the educational realm and funding for training (Tokuhama-Espinosa, 2011). Neuroscience-based methods, theoretical frameworks, and tools (Sigman, Peña, Goldin, & Ribeiro, 2014) have expanded the understanding of mind, brain, and education science and have helped answer the question, “How does the brain work?” (Boyles, 2014, p. 406). Leaders are required to better understand the importance of brain-based learning research to disseminate this knowledge to teachers (Lynch, 2016). Educational stakeholders are obligated to know which influences and factors determine student achievement and overall learning. The evidence found in neuroscience can provide a guide for principals and the instructional goals and expectations for their schools (Degen, 2014).

Leading experts in mind, brain, and education science have studied the elements of this evolving interdisciplinary field. Tokuhama-Espinosa (2011) identified the combination of mind, brain, and education science as a discipline for academics. She called for policy makers and educators to continue following brain-based research to bridge the relationship between educators and neuroscientists; change the way educators teach; disprove neuromyths; incorporate mind, brain, and education foundations and practices into curriculum and learning; and ensure that all educators are trained accordingly (Tokuhama-Espinosa, 2011).

Statement of the Problem

Researchers have evaluated the significance and variation between traditional instructional practices and those that are more student centered to determine which have more impact on student achievement. Principals, specifically, need to be knowledgeable of evidence-based strategies and practices (Lynch, 2016). Learning and the effects of selected interventions have been measured, along with the variances of achievement between schools and groups (Shen et al., 2012). The purpose of this research was to determine the association between principals' perceptions of brain-based learning and instruction at their schools. Gaps were found in the literature concerning the association between the principal's perceptions of brain-based learning and classroom instruction. Based on the literature review of mind, brain, and education science and the constructivist theory framework, the researcher established emerging mind, brain, and education themes and measured the impact principals' perceptions of mind, brain, and education science had on instruction. By increasing use of the combination of mind, brain, and education science in the classroom, student learning may improve (Tokuhama-Espinosa, 2011).

Research Questions

1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?
2. What are the themes among principals concerning brain-based learning?
3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?

Conceptual Framework

The researcher used a qualitative method. For this study, a case study and individual interviews provided the data necessary to determine principals' perceptions of brain-based learning and the impact on instruction in their schools. Qualitative methodology was selected because the entire study is rooted in philosophical principles and the constructivist doctrine (Bamkin, Maynard, & Goulding, 2016). By using the qualitative method, the researcher generated themes related to principal perceptions by examining their perspectives, experiences, and knowledge (Johnson & Christensen, 2017). The intent of the research was to understand and interpret the meaning of principals' perceptions of brain-based learning. The researcher determined a pattern of meaning as data were collected by using a constant comparative approach (Creswell, 2014). The case study research and interview sessions focused on the structure, meaning, and essence of the consciousness and experience from the viewpoints of the participants. Each participant was assumed to have varied experiences and unique meanings attributed to those experiences (Bakanay & Cakir, 2016).

The researcher analyzed the data to construct and interpret individuals' views (Bamkin et al., 2016) using semi-structured methods (focus group and individual interviews) while exploring guiding research questions (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). The study was designed to understand any norms, behaviors, interactions, differences, and perceptions among the individual participants (Johnson & Christensen, 2017) to help answer the research questions regarding mind, brain, and education science. The focus group data provided the participants' direct words to gain textual descriptions of how principals experience mind, brain, and education science (Mack et al., 2005). The interview sessions gave participants and the researcher a narrative inquiry to document their beliefs about strategies and activities that support brain-based learning (Zenkov & Harmon, 2009) at their particular schools. This process enabled principals to represent, identify, and enhance their perceptions of brain-based learning in their schools to reflect, record, and promote dialogue in the focus group and individual interviews. Principals were allowed to explain their stories concerning the implementation of brain-based learning at their particular schools (Wang & Burris, 1997).

Teachers are expected to have the necessary knowledge for teaching and learning, but studies have indicated the leadership of the principal directly affects how strategies, curriculum, and overall instruction are implemented (Goleman, 2014; Padron & Waxman, 2017; Pierce, 2014). Principals with the appropriate critical knowledge are able to guide and assist teachers (Padron & Waxman, 2017). The rationale for the qualitative study, following the theoretical framework of a constructivist theory, came from the idea that principals are expected to lead and increase engagement, commitment, and capacity for school goal attainment. Categories and themes that built a relationship in regard to brain-based learning were determined based on the collection of data from the case study (Balyer, 2012). Figure 1 shows the expected intersection of perceptions, theories, and practice for the study.

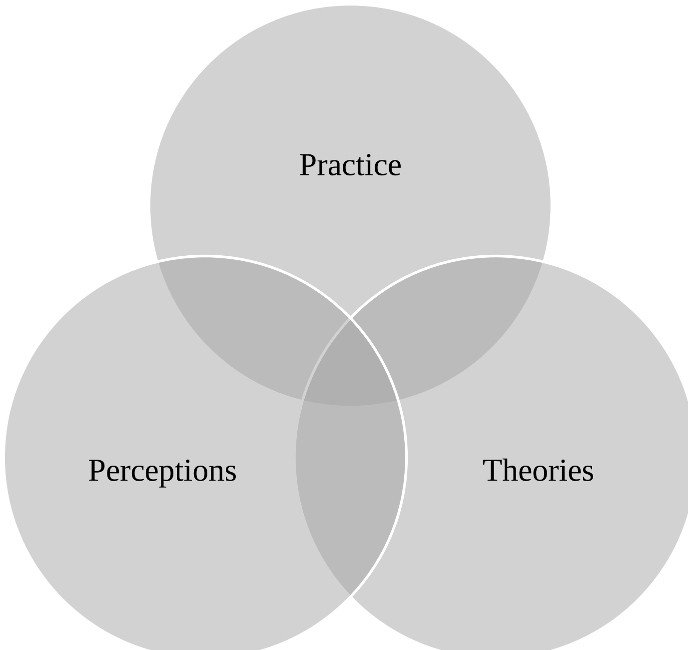

Figure 1. Conceptual framework going into the study.

Significance of Study

The purpose of this study was to determine the association between principals' perceptions of brain-based learning and instruction at their schools. The research design included a qualitative case study to identify the perceptions and themes of mind, brain, and education science among principals. The knowledge of these common elements was useful in determining the patterns found among various principals and the impact the leaders' perceptions of neuroscience had on brain-based learning in the classroom. The data collected suggested that principals' perceptions directly affect the implementation of brain-based education. The research methods included a focus group and individual interviews. By better understanding principal perceptions and identifying themes within the data, the study findings allow practitioners to consider the effect principals have on the implementation of brain-based instruction in their schools, and how the fields of neuroscience and academics are connected to instruction and student achievement.

Current research has emphasized brain function and how people learn (Vyas & Vashishtha, 2013). Studies have shown that without executive functions, such as attention and memory, minimal learning takes place. The human brain uses assorted memorizing systems, and many memory systems operate autonomously. Declarative memory involves memorization that is experienced and consciously declared. Inputs, such as pictures, text, and words, are captured by students in class and put into short-term memory. Most of these types of inputs are placed in short-term memory for a few seconds but dismissed without memorization (Degen, 2014). Directing learning based on the structure of how the brain attends and memorizes is essential to the learning process (Handayani & Corebima, 2017).

The emphasis on student achievement based on standardized tests is a major concern in education. This emphasis stems from the No Child Left Behind Act (2002), which mandated that schools meet selected yearly goals. Although teachers provide the direct instruction, principals need knowledge to support the teachers as the instructional leader. Research has shown that school leadership strongly impacts student success (Padron & Waxman, 2017). Leadership is second to teaching in factors that impact the learning level of students. In addition, principals affect student achievement by impacting teacher efficacy (Pierce, 2014). Leaders' attentiveness to themselves, others, and their schools helps cultivate their ability to manage, innovate, and strategize

(Goleman, 2014). As society becomes more complex, leaders also should adapt to meet the needs of these societal ramifications. An effective principal exemplifies leadership behaviors that improve the organization, change the organization as needed, and lead the organization towards the goal. In addition, principals inspire, influence, provide intellectual stimulation, and consider the individuals in schools (Balyer, 2012). Research has suggested that implementing brain learning principles and interventions boosts student achievement and learning (Butler, Marsh, Slavinsky, & Baraniuk, 2014; Gulpinar, Isoglu-Alkac, & Yegen, 2015). Given the principal's critical role in directing learning in the school (Gurley, Anast-May, O'Neal, & Dozier, 2016), principal knowledge and perception regarding brain-based learning are important to understand and develop.

The perceptions of educators concerning select topics and themes have been an indicator in research concerning instructional practices (Balyer, 2012; Gurley et al., 2016; Heystek, 2015; Padron & Waxman, 2016). A principal's understanding of a program is vital for successful implementation and sustainment. Often teachers lack the necessary knowledge of selected content, which is compounded if the instructional leader of the school has the same deficit (Padron & Waxman, 2016). Correspondingly, Gurley et al. (2016) analyzed perceptions of leadership behaviors to note the importance of the principal in the instructional leadership role.

Methodology Overview

Data Collection Procedures

Data collection took place following Columbus State University Institutional Review Board (IRB) approval (see Appendix A) and consent by the county board of education and the researcher's employer (see Appendix B). The participants were principals from the researcher's county. The researcher used stratified purposive sampling and preselected criteria. All 23 elementary school principals in the county were asked to participate (see Appendix C). Of the 23, 12 were selected based on ethnicity and gender to include a representative sample. The participants were six White females, two Black females, and two White males. The participants were at the elementary level, and five were at Title I schools. The county of employment has mandated each school use an instructional framework that includes a standards-based classroom. This framework includes brain-based learning instructional principals and strategies. At the time of this study, the principals were assumed to be knowledgeable in this area and to have a strong understanding of these practices.

The focus group meeting took place after the close of the school day in one school's media center. Do not disturb signs were posted to prevent interruptions, and the interviewer and participants sat in an area of the media center where no one could see the group from the windows. Only the credentialed interviewer and the participants were present in the room. The interviewer asked all the questions, audio recorded the focus group or interview, and took notes. After the focus group session concluded, a stenographer transcribed the recordings verbatim using NVivo (QSR International, 2018). The length of the focus group interview was approximately 50 minutes.

Before the focus group began, a consent form was given to each participant (see Appendix D). The form explained the purpose of the study and expectations, informed participants that the meeting was strictly voluntary, and stated all identifies would be kept anonymous (Mack et al., 2005). The focus group interview was semi-structured (see

Appendix E). The protocol included the necessary elements of interviewing and descriptive, structural, and contrasting questions (Spradley, 1980). No materials were provided to the participants during the focus group. All questions were free flowing and answered based on a rotation within the group (Spradley, 1980). No specific questions were given to specific principals at the time the focus group met.

The focus group interviewer asked questions (Creswell, 2014) based on themes from literature, such as professional learning and perceptions of brain-based activities and strategies (Johnson & Christensen, 2017), along with the guiding research questions from the study. Participants in the principal focus group were expected to be fluent in their knowledge and active with their responses the entire time, and no additional questions were anticipated. The interview process was open ended in nature, included questions read aloud by the interviewer and then recorded. The interviewer asked 11 questions of the focus group. Results were analyzed and coded based on the statements of the participants. Based on the coded data from the focus group, four additional individual interviews were completed following the same procedures to determine specific principals' perceptions more extensively and ask additional questions (see Appendices F and G). Through extensive coding (Chandler & Baldwin, 2010), the researcher noted any variance in perception of brain-based learning and established themes from the interview data (Zenkov & Harmon, 2009) to understand connections made concerning brain-based learning.

Data Analysis Procedures

The construct for this study was to look for common knowledge among the perceptions of the group to determine any emergent themes (Creswell & Poth, 2018).

The answers to the questions were transcribed and put into categories based on codes. Hughes and DuMont (1993) suggested three categories: descriptive, story, and abstract. Descriptive narratives are characterized by actions or events over time and help the researcher build an image of the participant's role. Descriptions between the participants are identified and assist the researcher in identifying patterns. The story narratives are reconstructions for particular events and allow for an interpretation for those events. The abstract narratives are generalizations based on common experiences. These statements describe groups of people (Hughes & DuMont, 1993). For this study, the researcher collected descriptive statements because the intention was to determine the perceptions of the principals. The researcher noted patterns from the participants' responses (Spradley, 1980) regarding mind, brain, and education science; principals' values of this newer discipline; and the impact principals' perceptions of mind, brain, and education science had on classroom instruction. By coding the statements collected from the focus group and individual interviews, the researcher worked to disaggregate common themes as patterns emerged (Miles & Huberman, 1984) by connecting the descriptive statements (Hughes & DuMont, 1993).

Upon submission of the transcripts, the researcher first analyzed them to note any key words and variance in perception of brain-based learning (Chandler & Baldwin, 2010). The researcher originally analyzed the transcripts by writing down key categories in the columns of the notes for each question. The analysis continued by reading the transcripts numerous times and identifying categories, subthemes, and themes from the data (Zenkov & Harmon, 2009) to understand any connections made concerning brain-based learning. The researcher analyzed the transcripts by highlighting the text within the interview notes, taking notes, and creating a chart with themes and subthemes. By comparing the transcripts, the researcher determined some key descriptors (Harkness & Stallworth, 2013). Then subthemes were determined to categorize the information. Nine key categories were identified: environment, neuroscience, leadership, perception, student learning, instruction, curriculum, teacher, and professional development.

This data showed the learning environments included key brain-based learning concepts. Decisions were made as all the data were collected and experiences were noted (Tokuhama-Espinosa, 2011). Based on the transcripts analyzed, the researcher determined whether the participants' perceptions of brain-based learning were similar and whether principals understood the critical components of mind, brain, and education science.

Limitations and Delimitations

The goal of the researcher was to understand the impact of principal perception on brain-based education. The literature showed that mind, brain, and education have been integrated into a newer discipline that should be considered by educators to evolve with advances in technology, science, and the skills needed for the 21st century. The principals' philosophies and experiences guided this study to determine the impact on brain-based learning. The collected data substantiated that the principal's perception does directly affect the implementation of brain-based education.

Limitations of the Study

The constraints of this study affected the outcome. The population of the study was centrally located in one county. In addition, the targeted participants were all elementary principals. School-level performance was not an indicator considered when gathering the information from the participants. More time and ongoing study may be needed to delve deeper into brain-based interventions and practices. In addition, challenges included scheduling, obtaining enough information from the interviews, and finding time to transcribe and evaluate all the data (Mack et al., 2005).

Delimitations of the Study

The researcher delimited this study to only currently serving elementary principals in one county. This parameter was in place to allow the researcher the opportunity to interview principals and determine any themes, relationships, and perceptions of the principals. By limiting the interview to a focus group and selected individuals, the researcher had a clearer understanding of the perceptions noted and how the perceptions impacted instruction or the emphasis of brain-based learning at the particular school. By understanding the context and meaning gained from the participants, along with the processes of the focus group and interview sessions, the researcher developed explanations to help answer the guiding research questions (Maxwell, 2009).

Definition of Terms

The terminology used in a study should be clarified for the reader. The vocabulary used addressed the issues and data. These terms are defined based on the literature and knowledge established at this time.

Brain-based learning: Involves techniques acquired through research in cognitive science and neurology that are used to improve teacher instruction (Connell, 2009).

Brain plasticity: "The capacity of the brain to change structurally and functionally over the entire life-course, due to experience as well as genetic and biological factors" (Rees, Booth, & Jones, 2016, p. 8).

Emotion: "An acute, intense, and typically brief psycho-physiological change that results from a response to a meaningful situation" (Artino, Holmboe, & Durning, 2012, p. e149).

Engagement: This refers to students in the classroom as active learners, a sequence of exploration, and connections made to a concept or skills (Kwek, 2011).

Instructional leadership: Refers to a leader whose behaviors or functions involve three dimensions: "defining the school mission, . . . managing the instructional program, . . . [and] promoting a positive climate" (Hallinger & Murphy, 1987, p. 57).

Inquiry-based instruction: Promotes "student inquiry and discovery in an authentic context" (Greenwald & Quitadamo, 2014, p. 2).

Mapping: A process in which new learning is connected to previous learning and linked to the prevailing system (Gozuyesil & Dikici, 2014). Balim (2013) explained mapping has been "described as a visual technique that presents the knowledge, ideas, concepts, and the relationships between them in an individual's mental construction on a two-dimensional plane" (p. 338).

Mind, brain, and education science: Refers to the intersection of three disciplines; the bridge between education, neuroscience, and psychology; and the usable knowledge for effective teaching and learning (Tokuhama-Espinosa, 2011).

Neuromyth: "A misconception generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research in education and other contexts" (Dekker, Lee, Howard-Jones, & Jolles, 2012, p. 1).

School climate: The school's health or the soul and heart, the character or quality (Allen, Grigsby, & Peters, 2015) of the school, which can only be felt and not touched, "the quality of institutional life promoted by student learning through the emotional, physical, and social safeties of the school (National School Climate Council, 2007)" (Ross & Cozzens, 2016, p. 163).

Transformational leadership: A leadership style "whereby a person engages with others and creates a connection that raises the level of motivation and morality in both the leader and the follower" (Northouse, 2015, p. 162).

Summary

The intent of this study was to research the extent of knowledge and perceptions among elementary principals concerning brain-based learning. The results established themes among principals, relationships between the principals' perceptions, and the impacts of these perceptions on instruction in each school. With the rigorous standards and expectations in the educational field, stakeholders have been required to acquire knowledge and skills to yield higher levels of student learning and performance. Educational leaders in particular are held accountable to these standards and expectations to provide the necessary culture, professional learning, and knowledge to transition their schools to meet the stringent mandates with learning and accountability.

With the integration of mind, brain, and education science, the literature has shown a need to embrace the principles of brain-based learning through scientific research and the development of technology in neuroscience. The analysis of this topic and information gathered concerning how people learn have suggested educators should rethink instructional practices by bridging neuroscience and education research. By examining how students think and the instructional practices in place, educational stakeholders concluded the integration of brain-based instruction is beneficial for education. The evidence in this study serves as a guide for school leaders, adds to the current literature, and shares information on mind, brain, and education sciences. By determining the relationship, knowledge, and perceptions of various elementary principals, information is shared to improve student instruction and pedagogy.

CHAPTER II

REVIEW OF LITERATURE

Many studies have been completed concerning academics and psychology, but the world of neuroscience is of interest to many in education (Hruby, 2011) due to developing and emerging concepts of cognitive neuroscience and neurobiology (Degen, 2014). Merging neuroscience and education in a way meaningful to both areas is a relatively new concept. Discussion and research to join the two entities continue to have a significant impact on the educational field (Tommerdahl, 2010). By joining research on the learning process and brain functions (Degen, 2014), research on brain-based learning emerged. This movement to integrate fields allowed cross-talk between the two disciplines to share research and join educational neuroscience with educational reform (Zadina, 2015).

Researchers have considered neuroscience foundational to educational practices (Clement & Lovat, 2012), and the information linking neuroscience and education has been used to improve learning potential (Pera, 2014a, 2014b). By the 1990s, brain-based learning gained attention and acceptance, and the domain of cognitive science was recognized by educators and linked to mind, brain, and education degrees; journals; and peer-reviewed literature (Degen, 2014). By using neuroscience content to assimilate new concepts, students increased their critical thinking abilities when they used multimodal learning and environmental stimulation to increase attention and attending behavior within the schooling process (Pera, 2014a, 2014b).

Previously, education and neuroscience research studies were separate, but a transdisciplinary movement allowed the different disciplines to become more interwoven. Scientists and educators realized this merger allowed for the formation of knowledge and addressed solutions for problems in the classroom and in education in general (Tokuhama-Espinosa, 2011). Rees et al. (2016) suggested the need for educators and neuroscientists to work together. The professionals from these two fields can work to analyze findings and find transdisciplinary benefits to continue this process (Rees et al., 2016).

Core 21st century expectations have required leaders to become advocates for an investment of learning needed for future work (Kwek, 2011). How the brain processes, perceives, stores, and retrieves information, interconnecting the brain and learning, is an important guide for pedagogy (Vyas & Vashishtha, 2013). Vyas and Vashishtha (2013) posited that brain-based learning is beneficial in improving student achievement, and Urick and Bowers (2014) postulated principal perception as a direct indicator and influence of academic climate and student achievement. As the instructional leader of the school, principals require skills to increase learning and achievement. These skills require an overarching focus on instruction (Sisman, 2016) and an awareness of what teachers need to accomplish school goals (Padron & Waxman, 2016). In this chapter, relevant studies have been reviewed to determine the impact of principal perceptions of brain-based learning through the physiology of neuroscience, curriculum and instruction, the professional learning needs for education, and the leadership influence and perspectives of brain-based learning.

Theoretical Framework

The foundation of this study was structured around the constructivism theory. The framework for the study was based on understanding individuals' perceptions and exploring how these perceptions affect outcomes (Gurley et al., 2016). This worldview was used to determine and interpret various principals' perceptions of mind, brain, and education science and how this knowledge influences student achievement. The philosophical assumptions and experiences guided the research inquiry to gain meaning from the participating principals (Creswell, 2014).

Teachers are expected to have the necessary knowledge for teaching and learning, but studies have indicated that the leadership of the principal directly affects how strategies, curriculum, and overall instruction are implemented (Goleman, 2014; Padron & Waxman, 2017; Pierce, 2014). Principals need the appropriate critical knowledge to guide and assist teachers (Padron & Waxman, 2016). The rationale for the constructivist theory was that principals are expected to lead and increase their organization's engagement, commitment, and capacity for goal attainment. For this research, categories that build a cause-and-effect relationship were determined based on interviews with the participating principals (Balyer, 2012).

The cognitive tools (interviews) gathered the individuals' knowledge, beliefs, and other information concerning mind, brain, and education science. This information assisted in determining and constructing new understanding of the relationship between the principal and mind, brain, and education themes that affect student learning. The guiding questions allowed the researcher to develop a theory and make recommendations for the discipline of mind, brain, and education. These answers were outcomes of this study and offered recommendations for further research.

History of the Mind and Brain

Early Records

Early records, 3000 BC, showed students were sent to school to learn wisdom, and as time continued the brain became considered a source of knowledge, wisdom, and human sensation (Ferrari & McBride, 2011). Around 460 BC, Hippocrates originally identified the brain as the origin of human wisdom, knowledge, and sensation. People debated whether the brain or heart dominated human psychological life (Ferrari & McBride, 2011). Different theorists, to include Leonardo da Vinci and Andreas Vesalius (1508–1543), discovered and sketched specific areas of the brain and the suggested functions (Ferrari & McBride, 2011). Later, in the 17th century, creative scientists gathered to disseminate a new philosophy regarding the human brain and how humans learn. During this time in history, thinking constituted one's primary function in life, and individuals were expected to create, think, and produce (Tokuhama-Espinosa, 2011).

1800s

Later in the 1800s, brain and mind ideas were linked to psychology. In 1896, Mark Baldwin linked learning to evolutionary selection in a theory called the Baldwin effect. Individual learning in animals benefited their species and was passed to descendants (Ferrari & McBride, 2011). Scientists also established the brain had two lobes in the two language areas of the brain; the left frontal lobe was found by Broca in 1862, and the parietal lobe was found by Wernicke in 1874 (Ferrari & McBride, 2011). .

1900s

Likewise, in 1911, Ramon y Cajal identified neurons as the basic encompassing structure and function within the brain. (Ferrari & McBride, 2011). Soon after, Donald Hebb (1949) described the neurological action where circuits form in the brain when cells are activated. From this discovery, the knowledge of plasticity within the brain originated (Hohnen & Murphy, 2016). These early discoveries started conversations and research on how the brain, mind, and learning are intertwined; such research has continued (Ferrari & McBride, 2011).

Historically, little was known about the brain (Bakkum, 2015), but researchers Caine and Caine (1994) reported connections made between classroom pedagogy and brain functions. Brain-based learning became more accepted during the 1990s. Higher level master and doctoral programs were created; more literature was published on cognitive science; and the journal *Mind, Brain, and Education* was published (Degen, 2014). Soon mind, brain, and education terminology was used in educational research synonymous with educational neuroscience, brain-based learning, and other words in numerous publications to describe this multi-perspective approach (Smeyers, 2016).

Education was believed to be the natural human thirst to understand the self and gain wisdom (Tokuhama-Espinosa, 2011). As time progressed, interest in learning and psychology increased. In the 1900s, Hebb (1949) explained the mechanism of neurons in the brain, and Piaget and Vygotsky contributed to education from the psychological standpoint (Ferrari & McBride, 2011). As these concepts and contributions developed, the field of neuropsychology emerged (Ferrari & McBride, 2011). Teaching practices were questioned, debated, and researched (Tokuhama-Espinosa, 2011). Malleable intelligence, brain plasticity, and application of cognitive and metacognitive skills were identified as concepts needed for students to achieve their maximum academic potential (Wilson et al., 2015).

Multidisciplinary Connections

When neuroscience, education, and psychology came together, early developments yielded theories on the interaction of the brain, behavior, and learning. Educational neuroscience was aimed at emerging insights that combined the embodiment of the mind and values that exemplified the type of citizen and society desired (Ferrari, 2011). Various hypotheses were tested, and some proved effective in education. Brain-based learning, educational neuroscience, educational neuropsychology, educational psychology, cognitive psychology, and neuroscience emerged as selective disciplines. Some areas included learning, whereas others included the study of systems, behaviors, and biology (Tokuhama-Espinosa, 2011).

The exploration between the educational and brain-based learning fields has been recent. No one fully understands the brain and how learning takes place, but established facts about brain function and development are key to informing educators and maximizing instruction and learning (Hohnen & Murphy, 2016). This new field was developed to devise ways for knowledge translation and methods to enhance teaching and learning (Pasquinelli, 2012).

Hohnen and Murphy (2016) posited an integration of education and brain-based learning, which allows teachers to work effectively with students and not waste time on ineffective interventions. As neuroscience and knowledge of the brain have continued to evolve, a worldwide movement has developed to gain information and inform educational practices (Hohnen & Murphy, 2016). A paradigm shift has led teachers and neuroscientists to join together and think about how people learn, examine the processes used to teach, and rethink teaching and learning based on findings. In interweaving the different disciplines, the historical roots of each discipline have been considered, along with the foundations that affected the philosophies of the professionals within the discipline (Tokuhama-Espinosa, 2011).

Physiology of Neuroscience

The Brain

The brain is an organ that serves as a whole unit and is unique to each person (Duman, 2010). This organ encompasses the most elaborate and complex systems (Schenck & Cruickshank, 2015) that neuroscientists and educators have examined (Tommerdahl, 2010). Understanding the physiology of the brain and the ongoing process of learning is important for educators (Wilson et al., 2015). By increasing knowledge about learning and the brain, all educational stakeholders may understand the various roles needed in designing and guiding instruction in the school setting. This understanding increases the importance of developing knowledge among not only the learners but also the teachers and leaders of the school (Conner & Sliwka, 2014).

Learning is a natural mechanism for survival. When considering brain functionality, neuroscience research has indicated selective learning involves the brain stem and the prefrontal lobes (Schenck & Cruickshank, 2015). Three parts of the brain have been identified as the triune brain: the cortex, midbrain, and hindbrain. Each houses different functions. The cortex ensures executive skills (Hohnen & Murphy, 2016). Cognitive skills such as attention, memory, inhibitory flexibility, and control are included in executive skills (Schachter, 2012). The midbrain ensures long-term memory, emotion, and reward systems; the hindbrain ensures survival (Hohnen & Murphy, 2016).

Learning Structures

Brain-based learning allows educators to design learning models that align with the natural processes of the brain and prepare students to process, store, and retrieve information (Handayani & Corebima, 2017). Neuroscientists, through analysis of cognitive and neural structures, have expanded the understanding of the brain in human behavior and development. For example, cognitive neuroscientists work to better understand the neural foundations of cognition. This work, along with a partnership with practitioners, continues to be an important relationship to enrich human behavior, thought, and learning (Pera, 2014a, 2014b).

Based on foundational principles of the brain, five concepts for mind, brain, and education sciences have been established (Tokuhama-Espinosa, 2011):

1. Brains are all unique to each individual.
2. Brains are not all equal due to the ability to influence learning and context.
3. Brains change through experiences.
4. Brains are highly plastic.
5. Brains connect new knowledge to old knowledge.

These principles, or variations of the principles, are found throughout the literature (McCall, 2012). When educators follow brain-based principles in their instruction, the focus is on student learning (Vyas & Vashishtha, 2013). A teacher may consider an individual's learning style, with student learning styles having significant implications in the classroom (Gulpinar, 2005). Dewey (1916) supported collaboration within the classroom and a connection between passive and active activities. Based on these principles, classroom experiences are supported by a curriculum that follows an interactive and experiential learning framework (McCall, 2012). Teachers should understand how brain functionality incorporates the new learning into previous schema. The importance of the relationship between the environment and the brain is understood, impacting instructional design (Vyas & Vashishtha, 2013).

Environment

Setting the correct stage or environment for learning through the classroom environment is another important part of the teacher understanding the brain. Learners need active ways to reinforce concepts and to promote positive behavior and information processing (Conner & Sliwka, 2014). Teachers should create a safe, secure environment and provide multisensory approaches when instructing (Smeyers, 2016). When designing the environment, the teacher should consider the learner as the primary participant, provide a space to encourage cooperative learning, attune to the learner, consider individual differences, provide a challenging workload but without excessive work, state clear expectations, and promote real-world problems and cross-curricular instruction (Conner & Sliwka, 2014).

Brain Plasticity and Malleability

Researchers have discovered that brains are plastic and malleable (Schachter, 2012). Plasticity occurs throughout a human’s lifespan but is more progressive in childhood. Chemical predispositions allow the brain to modify during experiences (Hohnen & Murphy, 2016). Neuroscientists have found that brain structures, interconnectivities, organizations, and neurons change throughout one’s life. This plasticity of the brain is affected by the environment and experiences (Rees et al., 2016). When considering plasticity, Hohnen and Murphy (2016) affirmed limitations, but this concept has been an important revelation in the neuroscience and educational fields (Masson & Foisy, 2014).

The brain is considered the learning organ and the classroom the place for learning (Vyas & Vashishtha, 2013). The brain's ability to change functionally and structurally over time (Rees et al., 2016) means it is malleable (Schachter, 2012). This malleability is based on experiences and biological and genetic factors (Rees et al., 2016). Often educators refer to students being ready for school or the next grade. The skills and mastery of standards are important to learning; however, schools often have not targeted instruction that correlates with the concept of brain plasticity (Wilson et al., 2015).

Learning requires chemical and electrical signals that connect neurons in selected brain areas. This neuronal connectivity, in time, causes changes that reorganize certain learning experiences (Tokuhama-Espinosa, 2011). Pera (2014a, 2014b) posited that experiences sculpt the brain's architecture, and distinct neural pathways process and represent various systems. In 1949, Hebb wrote the rule on Hebbian synapses; he posited that neurons fire together and as a result are wired together. This biological explanation was fundamental concerning plasticity and learning (Tokuhama-Espinosa, 2011). In *The Organization of Behavior*, Hebb (1949) stated,

> When an axon of cell A is near enough to excite cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or more cells such that A's efficiency, as one of the cells firing B, is increased. (p. 62)

Menary (2014) reported on the architecture of the brain and neuronal recycling. This concept was originally proposed by Stanislas Dehaene in 2005 (Masson & Foisy, 2014) in opposition to the former modularist view of the brain having specific areas responsible for discrete processes. Neural recycling is the reorientation of functions in the brain and supports the theory that neural circuits and areas of the brain share various tasks (Menary, 2014), but the brain is not altogether plastic. In neural recycling, the former circuits are modified by new learning, but some circuits are recycled more easily than others (Masson & Foisy, 2014).

Different neural systems are used when students learn, especially at school. Neural connections occur when a transmitter and a neuron connect with another neuron. Repeating activities cause a connection and the same circuit to fire. Firing causes a fat layer to wrap around and insulate the circuit and allows the action to be quicker and more effective. The process is named *myelination*, and the connections are characterized by white-matter images of the brain (Hohnen & Murphy, 2016). A critical component of academic development at school is the support of cognitive skills (Lemberger, Brigman, Webb, & Moore, 2012). By engaging students in tasks, brain circuits develop (Hohnen & Murphy, 2016), and learning strategies and memory activate essential intellectual structures (Lemberger et al., 2012). The positive cycle of learning includes six criteria, and children who do not access this cycle struggle in class and with general learning (Hohnen & Murphy, 2016).

1. First, task engagement occurs.
2. The student experiences success, positive feedback, and a sense of accomplishment, and the chemical dopamine is released.

3. The learner feels anticipation and desires to repeat the action.
4. Neurons are connected and circuits built.
5. Myelination occurs, and competence is built.
6. The learner has feelings and desire for success.

Memory

Another consideration is learning related not only to neural structures, but also to memory. Through literature reviews, Pera (2014a) found specific neural structures are used to process spatial and verbal information. Experiential learning causes the integration of various neural networks. Using more pathways and networks affects memory and makes more neural connections (Schenck & Cruickshank, 2015). When this information is determined to be ready for transfer, the brain accepts it into working memory (Pera, 2014a). Memory, specifically working memory, is the primary cognitive construct and directly supports academic success (Pera, 2014a). In addition, neural maturation, specifically the control of executive functions, helps determine the optimal time to introduce educational concepts (Pera, 2014a). Student retention of information increases when these connections are made through learning activities such as demonstrations of concepts using numerous modalities and personal explanations (Schenck & Cruickshank, 2015). The right and left hemispheres of the brain operate spontaneously but employ different concepts in diverse ways. The two hemispheres have specific functions to affective, physical, and cognitive activities, but neither hemisphere is superior. Likewise, these hemispheres determine how much time is spent thinking on particular issues (Duman, 2010).

Memory is also fundamental with learning, whether informal or formal. Long-term memory is required for success in school. Memories are based on survival, association, and emotion (Tokuhama-Espinosa, 2011). The amygdala is used with emotional processing, and the hippocampus facilitates memory. Both these areas are in the limbic system (Hohnen & Murphy, 2016). Often students struggling in math and reading have been diagnosed with working memory issues. Research has shown some students forget information presented verbally and cannot retain the information long enough to finish a math problem. Repetitive or rote interventions, often called “drill-and-kill,” do not work with this type of student, but practice with working memory may be successful. Functional magnetic resonance imaging (fMRI) has shown initial learning requires more working memory (Zadina, 2015).

Additionally, attention is important for memory and learning (Tokuhama-Espinosa, 2011). Attention is a principal component in schooling for student success. Attention influences the brain and the ability to learn; therefore, teachers must influence attention. Masson and Foisy (2014) reported teachers who gave attention to specific components in their instruction helped build more neuronal networks among students and used stronger instructional strategies. These and other brain-based learning strategies have helped build theories using neuroscientific data (Ansari et al., 2011).

Emotions

Emotions, decision-making, and social functioning are also key elements in cognition. The areas of the brain involving emotions are significant to learning, and emotional factors have extensive effects on cognitive development (Pera, 2014a, 2014b). A student’s psychological and emotional state dictates the productivity of the student’s learning. Positive emotions prompt self-motivation and increase the capacity and rate of information. Negative emotions interrupt the processing and systematizing of information. The student's perception of homework given affects the student's experience related to unpleasant emotions about the task. Moreover, achievement goals affect achievement emotions, and achievement emotions predict performance. Additionally, emotions (boredom, hope, anger, enjoyment, anxiety, pride, shame, and hopelessness) have been reported as related to performance attainment and achievement goals (Matuliauskaite & Zemeckyte, 2011).

Emotionally competent students are likely to become productive, healthy, caring, and effective adults. Responding to and processing emotions include using emotions when thinking, recognizing emotions of others, and balancing emotions to enhance positive behaviors. When students can label, recognize, understand, and manage emotions, they are likely to do better in school (Rivers et al., 2012); therefore, emotional states determine learning productivity. Matuliauskaite and Zemeckyte (2011) reported studies suggesting physiological parameters and stress affect learning efficiency. The results revealed that difficult mental academic tasks caused higher physiological and emotional reactions. Heart rate, perspiration, and blood pressure were all shown to affect learning productivity. These symptoms also decreased motivation to learn. The higher stress levels correlated to lower levels of production and motivation (Matuliauskaite & Zemeckyte, 2011).

Emotional research is relevant to mind and brain education. Emotions are complex and represent the physiological reaction to an external impetus. Research has suggested all decisions are made with emotions (Tokuhama-Espinosa, 2011). The affective filter hypothesis suggested feelings influence learning, specifically emotional states and stress. Decision-making is also essential to learning, and emotions directly affect decision-making (Tokuhama-Espinosa, 2011). Emotionality often has been viewed as part of one's personality and temperament, which are directly related to achievement (Valiente, Swanson, & Eisenberg, 2011). Additionally, brain processes with emotions notably affect behavior, and excessive anxiety impacts body and mind functions (Tokuhama-Espinosa, 2011).

Another theory concerning emotions involves the concept of emotional intelligence. Emotional intelligence requires emotional skills in not only academic functioning, but also personal and social interaction. Emotional intelligence allows a person to use emotion and reasoning to enhance problem solving and thinking. Emotional intelligence bolsters social functioning and well-being (Rivers et al., 2012). Cognitive function and executive function assist with skills associated with emotional and social learning, and schools have incorporated instruction to address emotional, social, and cognitive regulation and understanding (Sparks, 2013). In addition, resilient leaders who are emotionally intelligent are equipped to handle the continual changes in education to increase student achievement and success (Reid, 2008).

Mindset

The mindset for learning is based on a person's self-beliefs. This mindset affects motivation and the ability to accomplish tasks and achieve goals. The student's behavior also impacts learning regarding resilience and effort (Hohnen & Murphy, 2016). Motivation may be intrinsic or extrinsic and has a critical impact on performance (Cerasoli, Nicklin, & Ford, 2014). Cerasoli et al. (2014) asserted intrinsic motivation typically does not operate solely from other motivational types. The researchers found incentives were a predictor for intrinsic motivation, but intrinsic motivation remained a predictor for performance, even if incentives were missing or present.

Psychologists have reported the importance of students' knowledge and beliefs about the brain. Students who believed intelligence was fixed were not as successful and viewed learning as having a beginning and ending point. Typically, these students were motivated only to avoid punishment, gain recognition, and obtain higher grades. These students also gave up more easily, especially when presented with a challenge. Conversely, students who believed intelligence increased saw learning as flexible (Elwick, 2014) and had higher self-efficacy to reach goals (Bouffard & Savitz-Romer, 2012). These students viewed learning as incremental and believed efforts mattered; thus, they worked to develop abilities and skills, master new concepts, and adopt strategies for improvement (Elwick, 2014). Additionally, educators assisted students in developing a college mindset and learning to view themselves as a future college student. By integrating these expectations into their fundamental understandings, students were able to feel more confident (Bouffard & Savitz-Romer, 2012) and were more inclined to reach their goals (Hohnen & Murphy, 2016). This belief had an impact on academic achievement (Elwick, 2014).

In addition, teachers affected student beliefs concerning learning and had direct effects on learning outcomes (Tokuhama-Espinosa, 2011). Hohnen and Murphy (2016) noted the expectation of the teacher impacted learning, with a large effect size in the data. Teacher beliefs were crucial when considering the instructional decisions they made. These beliefs came from experiences with school, formal knowledge, and personal background (Zambo & Zambo, 2011). The belief of the teacher concerning a student, even if not spoken, affected the student's self-concept and approach to learning (Hohnen & Murphy, 2016).

Motivation

Established research has suggested the need for educators to address motivational and learning issues from a neurological framework (Hohnen & Murphy, 2016). An important part of the instruction given by the teacher is intended to motivate and instruct to develop intelligence (Wilson et al., 2015). To respond to this need, research on attitudes, practices, and neurological perspectives to pedagogy has continued (Tokuhama-Espinosa, 2011). King and McInerney (2016) directly correlated motivation and culture. Motivation was considered not only a personal trait but also as strongly influenced by contextual indicators. This interface between culture and psychological processes included motivational goals, conflicts, personal beliefs, student achievement, and engagement (King & McInerney, 2016). Because motivation is multifaceted, practitioners linked extrinsic incentives for motivation to tasks that were straightforward, less enjoyable, and repetitive. For intrinsic motivation, tasks were linked to activities that were personal, complex, and needed to be absorbed by the student (Cerasoli et al., 2014).

Minds respond to stress, and stress is typically a reaction to the difference between perceptions or expectations and reality. Students may perceive stress as moderate or more severe. The stress reaction causes chemicals (adrenaline, norepinephrine, and cortisol) to release and heighten the perception of the situation. Low levels of stress can be positive, increasing learning and motivation. However, Degen (2014) reported stress caused by tasks that were too challenging caused frustration and anxiety. Activity from the midbrain reduced when stimuli were threatening, and the information did not move into the cortex, or specifically the precortex, during fear, arousal, and anxiety (Hohnen & Murphy, 2016; Schachter, 2012).

Relating Brain-Based Learning to Education

The 1990s have been referred to as "the Decade of the Brain" (Ferrari & McBride, 2011, p. 89), and by the 2000s, brain-based learning surfaced. The forerunners in this movement, Caine, Caine, Jensen, Crowell, and Sousa, consolidated the nexus of psychology and neuroscience into research-based brain-based learning (Connell, 2009). Although the field of neurology has not resolved all of the educational issues, this new vision between fields can impact the process of learning, teaching, and reform (Zadina, 2015). The field connecting the brain, mind, and education is still young, but literature has shown its recognition as a science (Ferrari & McBride, 2011). Research has connected the brain, how it works, and education (Breen, 2014). Educational neuroscientists have explained development and learning and determined how knowledge is embodied (Ferrari & McBride, 2011).

Neuroscience includes the study of physiology, biochemistry, anatomy, and molecular biology (Boyles, 2014). The premise for brain-based learning is rooted in meaningful learning (Gozuyesil & Dikici, 2014). What the brain does, how it works, what happens during learning, and how one remembers are issues important to instructional design. Beliefs, motivation, and intelligence all affect how information is received (Elwick, 2014). Brain-based learning requires educators to have a foundational understanding of neurological findings and the relation to instructional strategies (Degen, 2014).

The main questions for educators and educational neuroscientists to answer are (a) how the brain works and (b) how to develop instructional practices that are scientifically valid and confirmed to enhance learning (Boyles, 2014). Research has indicated student achievement is impacted by teacher knowledge and perceptions about educational neuroscience, professional development and classroom strategies used, and curriculum choices (Zadina, 2015). By understanding the relationship between the neurosciences and education, professionals on both sides have the opportunity to learn and share feedback. This research directly affects pedagogy, and this partnership has continued to be cultivated to help inform and connect the puzzle pieces of the complex field of neuroscience to education (Tommerdahl, 2010).

Neuroimaging

Neuroscience is a multidisciplinary field and has evolved from behavioral observations to technology innovations that involve brain imaging. This imaging allows for knowledge in the neural processes that are applied to curriculum and educational practices (Clemet & Lovat, 2012). These imaging techniques can monitor tasks, sensory experiences, and neural connections (Liu & Chiang, 2013). For example, Harvard scientists found structural brain changes in fMRI scans from an 8-week program of mindfulness meditation techniques. The controlled breathing techniques helped build gray matter in parts of the brain that were denser on the scans (Atabaki, Dietsch, & Sperling, 2015). Moreover, brain imaging has helped educators recognize disparities between employed models of reading. The images demonstrated several distinct active locations when early childhood students were sounding out words, and a match for various locations when a struggling student was decoding (Hruby & Goswami, 2011).

Other scans included positron emission tomography, transcranial magnetic stimulation, encephalography, electroencephalography (EEG), and functional near-infrared spectroscopy. The fMRI and EEG scans have helped scientists to better understand cognition and behavior (Liu & Chiang, 2013).

As neuroimaging progresses, researchers have noted dramatic progress in understanding the brain, how it works, and how it is arranged. Neuroscientists better understand brain structures, interconnectivity, organization, and neurons. These findings suggest that neuroscience has matured as a discipline, and researchers have called for more collaboration between practitioners and neuroscientists (Rees et al., 2016). Hruby and Goswami (2011) proposed neuroscience and reading education research as the groundwork for understanding the subprocesses of conceptual reading challenges and methodologies regarding education practices. For example, auditory neuroscience has transformed speech processing. Advances in neuroimaging displayed how speech signals are coded neurally, which in turn gave educational researchers knowledge on the significance of speech rhythm and syllables over phonemes. As a result, this implication has raised debates and started conversations over oral language and phonics instruction (Hruby & Goswami, 2011).

For instance, neural activation studies have shown struggling readers have different neural activation patterns when compared to readers on grade level. Researchers examined images of different areas of the brain when reading (Hruby & Goswami, 2011). As studies like these continue to contribute to understanding, scientists need to share findings in a way that the educational audience understands and can apply to new learning (Tokuhama-Espinosa, 2011). Duman (2010) investigated the effects of brain-based learning using academic test scores and a survey. Students in a control group were taught using traditional lecture; students in the experimental group received instruction based on brain-based learning. The experimental group receiving the brain-based learning scored higher on the achievement test. Based on the study, Duman recommended class activities and lesson plans that model teaching and learning based on brain-based learning.

Traditional Lecture Versus Brain-Based Learning

Pera (2014a, 2014b) suggested neuroscience has contributed to educational practice, teaching and learning, and neurocognitive development. Pioneers like Vygotsky and Piaget changed the perception of how students learn through research by stating old information is merged with new information through the experiences and interpretations of individuals (Pera, 2014a). These early foundational experiences form primary knowledge for subsequent learning in adulthood (Liu & Chiang, 2013). Neuroscience researchers have informed pedagogy regarding experiences, noted exercise and nutrition help develop the brain, developed programs for instruction, and provided other information to help cognitive development (Ferrari, 2011). These findings also have informed pedagogy in other areas concerning the values behind education such as personal development, job training, and truth seeking (Ferrari, 2011).

Critical questions concerning the relationship of neuroscience and education require careful consideration. Some of these concerns are sustained connections between the disciplines; the effect of educational practices; the varying roles of neuroscientists, educators, and policy reformers; and the source of funding for continued research (Ansari et al., 2011). How neuroscience relates and is relevant to formal education requires careful review (Sigman et al., 2014). Cognitive neuroscience focuses more on the mind, whereas educational neuroscience focuses on the overall learning process and includes cultural influences of students and those with special needs (Ferrari, 2011). Although some neuroscientists have claimed the relationship between these fields is still too new to have widespread applications, the magnitude of diverse learners sitting in American classrooms (Connell, 2009) is reason enough to continue to increase and translate the knowledge in a way beneficial to all (Rees et al., 2016). The gap between the classroom and the brain cannot be bridged easily or quickly, but Masson and Foisy (2014) agreed that insights into both fields provide contributions in advancing learning.

Transdisciplinary Gap

Education has served as a great origin for inspiration for the research in neuroscience (Sigman et al., 2014), but one primary gap has been between the classroom and the laboratory. Neuroscientists rarely go into the classroom, and teachers rarely go into a laboratory (Breen, 2014). Therefore, constructive conversations are needed (Breen, 2014) as well as a blend of specialties within both fields, translational efforts with experience and credentials, and proper training (Zadina, 2015). This process requires sufficient organization, and neuroscientists need to communicate results that are critical and not just areas of commercial appeal. This dialogue of results requires the information to be presented and disseminated in a way that non-neuroscientists can understand and that supports pedagogy. Educational neuroscientists need an educator’s knowledge to advance more experimental designs, and the classroom serves as a lab for learning (Sigman et al., 2014).

Curriculum and Instruction and Brain-based Learning

Neuroscience information has not always offered specifics on how to instruct but can inform teaching, school reform, and learning (Zadina, 2015). Neuroscientists and educators have worked together to share the efforts and bridge the gaps. These ideas, paradigms, and visions have led to the continued development of new education practices (Zadina, 2015). Ferrari (2011) noted educational neuroscientists have helped identify differences in typical and atypical learners and how the brain functions as students learn. From the identified information, educational programs and technology have been created and environmental changes recommended (Ferrari, 2011). Often computer systems have been used to research the process when learning, and cognitive models have been determined. In addition, through neuroscience findings, computer learning algorithms have been developed to help teachers enhance mastery of different concepts. These tools also have assisted with the communication between students and teachers (Pera, 2014a, 2014b).

Brain-Based Learning Principles

To meet the needs of students and teachers, seven learning principles have been determined to aid in both contextual variables and learning content (Conner & Sliwka, 2014). These principles are interdependent.

1. The environment keeps the learner as the main participant, includes active engagement, and develops the learner as an active participant.
2. The teacher encourages organized cooperative learning and bases the environment on social learning.

3. The professionals in the environment are attuned to the motivations and emotions involved with achievement of the learner.
4. Individual differences of the learners and their prior knowledge are considered.
5. The environment requires hard work and a challenge but not an excessive workload.
6. Expectations ae clear, and assessments are aligned with expectations. Formative feedback is emphasized to support learning.
7. A connectedness with knowledge and different subjects is promoted along with the community and world (Conner & Sliwka, 2014).

Teachers who understand these principles view learning with an emphasis on the natural functions of the brain to drive curriculum and instruction (Handayani & Corebima, 2017). In 2014, the state of Georgia adopted the Teacher Keys Effectiveness System as a way to evaluate teachers. The expected standards for all teachers include a variation of these learning principles: professional knowledge, instructional planning, instructional strategies, differentiated instruction, assessment strategies, assessment uses, learning environment, and a challenging environment. Furthermore, Georgia requires classroom standards that include an analogous instructional framework of brain-based principles (Georgia Department of Education, 2017). An expansive knowledge base of research-based instructional strategies, the environment, and how students learn positively influences student learning outcomes (Conner & Sliwka, 2014).

Active Engagement

Active engagement allows learning to take place (Hinton, Fischer, & Glennon, 2012). The evolving concept about learning has moved away from continual reinforcement through drills and rote memorization to more active methods (Conner & Sliwka, 2014). Stimulation generates synaptic connections (Quin, 2012) and affects the architecture of the brain (Hinton et al., 2012). This engagement is important for the learning environment and has been recommended over lecture. Active learning is used in the classroom to keep students physically and mentally active and to allow students to self-assess and self-reflect, engage, and attain knowledge by contribution and participation (Quin, 2012).

Kall, Malmgren, Olsson, Linden, and Nilsson (2015) suggested exercise can affect cognitive function. Furthermore, physical activity positively affects psychological health, yet physical exercise declines dramatically into adolescence, with the resulting benefits lost to adolescents. Additionally, Kall et al. reported evidence that physical movement has benefits for various well-being outcomes. Physical activity has been linked to cognition, and cardiovascular exercise affects mental health (Kall et al., 2015).

Diverse Methods

Individuals learn in a variety of ways, and diverse methods of instruction have been recommended (Duman, 2010). Moreover, different instructional concepts require various instructional approaches (Tokuhama-Espinosa, 2011). With a nationwide emphasis on STEM, problem solving and critical thinking are key elements to prepare students for inquiry-based development (Balim, 2013). Methods that are not the typical lecture and that encourage inquiry-based practice require teachers to accurately identify student weaknesses and strengths using brain-based learning elements (Tokuhama-Espinosa, 2011). The American Association for the Advancement of Science has encouraged improvements in assessments and teaching methods for STEM classes (Fry, 2014). Real-world learning and critical thinking are key for mastery of content rather than rote memorization (Greenwald & Quitadamo, 2013). Gulpinar et al. (2015) found science instruction for medical school students that was rich in brain-based learning principles resulted in not only higher academic success but also more satisfaction with the instruction. Specifically, the exam scores improved from 41.1% to 73.9% over a single year when the program was reconstructed based on brain-based principles (Gulpinar et al., 2015).

Cognition

Neuroscientists have suggested optimal learning be centered with cognition (Liu & Chiang, 2013). Learners have various strategies for skills and cognition. New knowledge requires familiarization, and at times learners need more time with familiarization to understand new concepts (Hruby, 2011). Automatic learning is used in some types of learning that require rote memorization. For example, symbols, graphs, and technical learning require, at times, patterns to be memorized. Learners aware of the knowledge they are learning can apply old knowledge rules but also creatively think and gain new insights (Liu & Chiang, 2013).

The brain processes different learning through different pathways and memorizes information using different systems (Degen, 2014). Hruska et al. (2016) reported expertise and difficulty of reasoning tasks affected neural activity using fMRI. These images showed common activations in both groups, but images showed more activations in participants with less experience (novice) when reading clinical cases that were harder and easier. This was especially true when reading and processing more difficult cases. Hruska et al. found that the activation in the prefrontal area was associated with working memory and noted this as a distinction between the novice and expert participants.

Hermann Ebbinghaus in uncovered in 1913 that students lose 90% of learning within 30 days (Degen, 2014). Shaughnessy (2016) interviewed retired educational leader and consultant Marcia Tate and reported on 20 brain-based instructional strategies that Tate researched based on students' gaining and retaining of information. Tate developed strategies to assist in student understanding and content retainment and recommended these instructional approaches for daily instruction (Shaughnessy, 2016). Tate cited the following specific strategies that should be used by teachers to deliver instruction:

1. Brainstorming/Discussion;
2. Drawing/Artwork;
3. Field Trips;
4. Games;
5. Graphic Organizers/Semantic Maps/Word Webs;
6. Humor;
7. Manipulatives/Experiments/Labs/Models;
8. Metaphors/Analogies/Similes;
9. Mnemonic Devices;
10. Movement;
11. Music/Rhythm/Rhyme/Rap;

12. Project/Problem-based Learning;

13. Reciprocal Teaching/Cooperative Learning;

14. Role plays/Drama/Charades;

15. Storytelling;

16. Technology;

17. Visualization/Guided Imagery;

18. Visuals;

19. Work Study/Apprenticeships; [and]

20. Writing/Journals. (Shaughnessy, 2016, p. 204)

Balim (2013) supported this finding in a study analyzing the application of mind mapping and inquiry-based learning to seventh-grade students. The experimental group learned mind-mapping techniques, along with inquiry-based skills, during a science course of study. The instructional strategy of mind mapping specifically facilitated and enhanced learning by incorporating various content and other teaching strategies through a constructivist learning theory (Balim, 2013). Overall, brain-based instructional strategies have been found to improve retention of knowledge, achievement, motivation, and attitude (Uzezi & Jonah, 2017).

Meaningful learning requires students to link new knowledge to previous learning. This new knowledge is then connected and put into the present knowledge. An example of this connection is mapping (Gozuyesil & Dikici, 2014). The brain takes the pieces of knowledge and binds them together, which allows the learner to remember the information (Degen, 2014). Mind mapping is considered a visual, brain-based technique that allows students to use both sides of their brain. This mental model approach presents ideas visually that show how the ideas, concepts, and knowledge are all associated. A constructivist approach is favored for the student to construct individual knowledge (Balim, 2013).

Curriculum

Brain-based approaches can be used to explore ways to maximize learning (Gozuyesil & Dikici, 2014). Curriculum work has incorporated new understanding from neuroscience that has been translated into practical application (Clement & Lovat, 2012) by tapping into inquiry and problem-based experiences and employing metacognition (Wilson et al., 2015). Clement and Lovat (2012) stated curriculum involves content and pedagogy. The content includes an integrated student-based curriculum, and teachers encourage students to develop multiple learning competencies and skills (Azer, Guerrero, & Walsh, 2013). Curriculum is ever changing and fluctuates between educational foundations and curriculum theory (Clement & Lovat, 2012).

Math, reading, and science learning has been highlighted in neuroscientific research, along with the use of technology, to enhance learning through a multimedia approach. Videos, simulations, texts, and graphics have been used to portray concrete representations and give enhanced visualizations of conceptual and abstract ideas (Anderson, Love, & Tsai, 2014). Neuroeducation research has been used to note and understand the differences in brain functions through eye tracking (Anderson et al., 2014). Cognitive models for the reading process have been related to decoding of text and instruction (Hruby, 2011). This research involved fMRI and EEGs to distinguish various functions when problem solving, interacting with digital-based learning environments, and self-directed learning (Anderson et al., 2014).

Student-Centered Instruction

Student-centered learning approaches recognize the emotional needs of individuals. This type of approach helps students be motivated and gain self-confidence by matching learning to their interests and abilities. The ultimate goal is to support students as self-directed learners (Hinton et al., 2012). Liu and Chiang (2014) suggested six constructs using the theory of the whole brain to improve learning, especially in science: ontological, epistemological, methodological, developmental, evolutional, and affective or social. These constructs focus on the neural level.

1. Ontological learning involves working memory. Students often struggle with organizing information into working memory and become overloaded. Working memory processes with encoding, and resurgence research has suggested sleep helps consolidate memory.
2. Epistemological learning means students need exposure to the entire concepts while also probing the specifics about the whole. The brain needs multiple presentations of new information to identify patterns and adjust.
3. Methodological learning is needed, as learning is a process. As more neural paths are connected, more learning takes place through mind mapping.
4. Developmental learning is related to how sensory associations facilitate memory. Concrete experiences allow for interactions with the environment and build long-term neural connections.
5. Evolutional learning involves technology. Scholars have indicated that innovative and computer models used for teaching are more efficient and effective than conventional methods.

6. Affective and social learning occurs. A positive environment for learning accelerates learning because negative emotions such as grief, anger, and depression affect the learning process. Positive emotions and environment are correlated to effective learning (Liu & Chiang, 2014).

Challenges remain in understanding how students perceive and then process presentations in various environments. Learning theories and investigations continue with the instructional design of effective learning strategies at the forefront. Instruction is also a key challenge linking neuroscience, interventions, and developmental theories. Measuring instructional tasks to gain insight into psychological and brain operations guides instruction (Anderson et al., 2014), but claims have been made that were not scientific. Often the rhetoric of improving student achievement is used, and programs are implemented due to this description. In addition, findings of genuine research in neuroscience have been overgeneralized and require careful consideration (Liu & Chiang, 2014).

Higher Order Thinking

Higher order thinking allows comprehension and knowledge to be combined and synthesized to develop metacognition and use assorted memory systems. Lecturing in class allows for basic comprehension, but higher order skills allow students to apply the information to new contexts (Tokuhama-Espinosa, 2011).

Usable Knowledge

Tokuhama-Espinosa (2011) recommended key elements of usable knowledge for teachers using mind, brain, and education practices.

- Learning environments can be created for quality learning and teaching exchanges. Students feel challenged and secure, and work is meaningful.
- Learning is within the context of the learner. Students participate in authentic learning, and the teacher links past knowledge to new learning. Information makes sense and is logical to the student.
- The teacher understands the dependency of memory when students learn. Activities include memory storage experiences and development of a system to assist students with recall.
- Class time is broken into chunks to accommodate the maturity and age of the students to keep their attention. The classroom is student centered and includes engaging and interesting activities to keep student attention.
- Learning is social and active; students interact.
- Nutrition, physical activity, and sleep help nurture the body and impact the quality of brain function.
- Individuals need immersion in experiences that use critical thinking. The form of the class uses individual knowledge to help students develop their own understanding.
- Activities are prepared to keep learners involved and develop student skills rather than just information transmission.
- Reflective processes are emphasized. Metacognition is advanced by allowing reflective thought.
- Learning is for a lifetime and occurs developmentally through a process of skill acquisition (Tokuhama-Espinosa, 2011).

Knowledge of the brain has evolved over the years, and research findings continue to change how researchers view the brain. This affects the work of teachers in many areas (Aldrich, 2014). By informing educational practice, the integration of neuroscience and education has been fruitful, although knowledge and practice should be based on sound research (Rees et al., 2016). Some researchers have been skeptical and noted hypotheses were wrong, but effective research continues to determine disproven approaches before identifying useful information (Pasquinelli, 2012).

Collaboration between neuroscientists and educational researchers can yield practices and theories applicable to both fields. Neuroscientific evidence has been valuable for professional learning for educators. In addition, integrating fields has bridged the gap between the lab and the classroom. Imaging techniques have continued to improve, and studies have given practitioners effective and specific content strategies to use with students. This evolving relationship has provided and will continue to provide profound influence and information that will translate into classroom practices (Tokuhama-Espinosa, 2011).

Professional Learning Needs for Educators Regarding Neuroscience

Teacher Education

Teachers must not only understand the content but also know how to teach the content (Clement & Lovat, 2012). Training for teachers with certain aspects of neuroscience is crucial and needs to be included in teacher preparation within colleges and as continuing professional development within school systems (Ansari et al., 2011). Tokuhama-Espinosa (2008) noted the need for neuroscience education to correct former training where teachers learned how to teach and not how students learn. Ansari et al.

(2011) proposed a seamless flow between the classroom and the laboratory to increase student learning and intelligence. In addition, Kapadia (2013) found teachers had some knowledge and practice regarding brain-based learning but needed more professional development.

Furthermore, training neuroscientists, especially cognitive neuroscientists, in educational issues is important. Ideally, cognitive neuroscientists experiment, and educators apply the results of the research. By merging education and neuroscience, all stakeholders aim at helping students deeply understand concepts and flourish in society (Ferrari, 2011). Neuroscience findings have given learning professionals a better way to approach student learning and meet individual needs (Tokuhama-Espinosa, 2012). Handayani and Corebima (2017) suggested the best learning model centers on the brain and includes brain-based learning systems.

According to Conner and Sliwka (2014), the Organisation of Economic Co-operation and Development cited the main direction of education as including student learning, theories, and ideas about learning and suggested that applications based on these be the core of teacher education. Active methods allow learners to remember new material and apply it in different contexts. Teachers and students continually develop their skills and seek better approaches (Conner & Sliwka, 2014). Bouffard and Savitz-Romer (2012) also reported that teacher training should include social and emotional factors that impact students and their development. Motivation, identity, relationships, and self-regulation are pivotal when considering developmental processes and are indicators of student success (Bouffard & Savitz-Romer, 2012).

Educators and neuroscientists have considered cultural and biological facets of development and learning (Clement & Lovat, 2014). Hook and Farah (2013) studied teachers' expectations and knowledge of neuroscience research. Interview data showed that teachers sought pedagogical strategies and were curious about the brain (Hook & Farrah, 2013). Waree (2017) found teachers trained in brain-based learning had greater competency in instructional management. By increasing their competency, teacher training about brain-based learning was beneficial and had real relevance to their work as educators (Hook & Farrah, 2013; Waree, 2017).

The scientific knowledge of neuroscience needs to be used to create practices and strategies for brain-based learning that educators can use in the classroom. Scenarios encountered by teachers can be linked to applicable neuroscience research. For teachers to benefit from the findings, the research needs to be translated into practical strategies (Greenwald & Quitadamo, 2013). Another factor related to applicable neuroscience research is teachers' dispositions toward their own teaching. Alone, neuroscience is not likely to garner changes in educational practice. Clement and Lovat (2012) hypothesized an illustration between the two fields. They posited that neuroscience research described brain research findings, and educators then prescribed the applicable instruction. Some researchers have argued neuroscience findings for education have resulted in connections and associations that reframed learning through understanding the biological constraints (Clement & Lovat, 2012).

Neuromyths

New ideas concerning brain-based learning need rigorous standards and scrutiny to show evidence through various studies. The neuromyths concerning the brain and mind have raised pragmatic and theoretical concerns (Pasquinelli, 2012). Dekker et al. (2012) characterized a neuromyth as “a misconception generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research in education and other contexts” (p. 1). A strong emphasis should be placed on evidence- and research-based practices to deter wasted time, effort, and money. Teachers need accurate information to deter the proliferation of misconceptions. Future research is also needed to examine the originate misconceptions and include intervention studies that increase teacher knowledge of the brain (Dekker et al., 2012).

The Organisation of Economic Co-operation and Development led a brain and learning project in which 242 teachers completed surveys online (Dekker et al., 2012). Statements were listed regarding the brain and included 15 neuromyths. Results showed many misconceptions concerning neuroeducation, and teachers believed 49% of brain misconceptions, especially those promoted by developers of commercial educational programs (Dekker et al., 2012). Clement and Lovat (2012) alluded to the cognitive constraints that occur with neuromyths. Throughout research, all those involved should proceed with caution and not believe the myths (Ferrari, 2011). These misconceptions lead educators to believe false assertions concerning brain research (Pera, 2014a). Often educational products, strategies, and practices have been endorsed and modified when given a neuroscience label. For example, students with autism spectrum disorder have notable differences with neurocognition, but this knowledge has not always produced anything tangible for these students, other than laboratory findings (Ferrari, 2011).

Several myths have arisen from the different claims companies make when selling products, such as Brain Gym (Dekker et al., 2012). Dekker et al. (2012) also cited myths such as left- versus right-brain learners and misconceptions about learning styles. Pasquinelli (2012) reminded readers that the practice of science is intended to be in a continual state of correction. A hypothesis found not to be true provides the aperture for what is true (Pasquinelli, 2012). Often claims have been overgeneralizations and lacked conclusive evidence (Tokuhama-Espinosa, 2012).

An idea that one hemisphere of the brain is dominant is a popular myth. This idea captured the attention of many through articles and books (Tokuhama-Espinosa, 2012), yet the dichotomy was found to be false. The concept was disproven through brain imaging, and scientists found the two hemispheres do not work in isolation, but communicate and are linked (Atabaki et al., 2015). Another prominent myth has been the premise that humans use only 10% of their brains. Again, brain imaging research showed the brain to be highly interconnected with profound transfers of information and regional crossover. This neuromyth has been more common among the public than educators (Dekker et al., 2012).

The gap between neuromyths and scientific insights has become a growing challenge over the past decade or more. Continual dialogue between practitioners and scientific communities can help close these gaps (Atabaki et al., 2015). Neuromyths have been shown to be incorrect but often have origin in scientific findings, making them more believable. People are more likely to accept an idea when the neuroscience label is used and brain images included. Another source of neuromyths has been popular media. Articles simplifying complex neuroscience findings and concepts have led educators and the public to accept flawed assumptions. To combat this problem, teachers need neuroscience literacy and to rely on valid research (Dekker et al., 2012).

Student Identification

School systems often identify students by their brain functionality. As neuroimaging and educational neurology have advanced, knowledge has been gained about the brain's structures and arrangement (Rees et al., 2016). These types of brain functionality discoveries have required changes in the professional learning teachers receive, and in the tools and methods used to educate people (Conner & Sliwka, 2014). For example, the neurodiversity movement gained attention and momentum to bring about a change concerning anomalous learners. This movement included the concept that people with autism spectrum disorder do not have a handicap, but rather a condition of atypical neurological wiring (Ortega, 2009). This concept has been particularly important for those with atypical learning and performance (Ferrari, 2011).

Instructional Strategies

Moreover, instructional strategies are important. Dosa and Russ (2016) concluded correctness of concepts was important, but students who received more qualitative instructional methods had a richer sense of the selected topic. In addition, effective interventions do not always require excessive amounts of time, money, or expertise. Instead, a few small changes in instructional practices can make differences in student learning (Butler et al., 2014). Kall et al. (2015) explained the connection between cognition, fitness, and exercise. Kall et al. suggested the school environment is an arena in which to promote physical activities to improve academic performance.

Learning Styles

Felder (1996) defined learning styles as physiological, cognitive, and affective traits that indicate how people respond to, interact with, and perceive environments. Professional learning for teachers should include how and what a student will process while learning and the understanding that these styles are not fixed (Duman, 2010). Schenck and Cruickshank (2015) cautioned that experimental learning connects multiple pathways of neural networks. Limiting learning to a single learning style is not best. Instead, teachers should demonstrate concepts multiple ways through multiple modalities. Students should be allowed to demonstrate learning through various modes as well. Teaching to one learning style only may not yield measurable effects on achievement (Schenck & Cruickshank, 2015).

Student Achievement

Vyas and Vashishtha (2013) monitored and tested brain-based learning versus traditional lecture-based learning in the classroom using pre- and posttests. The experimental group received brain-based teaching modules targeting brain-based learning principles, including an emotional environment and physical environment that facilitated learning, learning designed to formulate cognitive maps, and various sources to help ensure mastery of the content. The experimental group receiving brain-based instruction scored higher than the control group (Vyas & Vashishtha, 2013). Gozuyesil and Dikici (2014) measured effect sizes in various quantitative studies that examined brain-based learning effectiveness. Their meta-analytical study included the academic achievement from 31 reports in the literature from 1999–2011. Gozuyesil and Dikici reviewed 42 effects and found 35 to have positive effect sizes, concluding brain-based learning was more effective.

Leadership Influence and Perspective

Principal perspectives on brain-based learning is an area of minimal research. This perspective is critical to understand the influence and implications principals have on their schools. These perspectives affect the beliefs and strategies promoted among staff and students (Iachini, Pitner, Morgan, & Rhodes, 2015). In particular, leadership is second to classroom instruction when considering student achievement (Brown, 2016) and may account for approximately 25% of indirect and direct effects on learning (Shen et al., 2012). School leaders fulfill a host of responsibilities other than operations and academic needs. Creating a positive school climate, preserving a vision, strengthening collaboration and partnerships, and supporting the staff are a few of the complex roles educational leaders serve (Iachini et al., 2015).

Leadership and School Improvement

In the 20th century, a school improvement effort dominated the United States. This reform included legislation requiring measurement of yearly progress (Allen et al., 2015). In addition, principals have become more responsible than ever for the achievement level of their school, and achievement is heavily scrutinized at the county, state, and federal levels (Ross & Cozzens, 2016). Part of this reform process also has reviewed leadership factors (Allen et al., 2015). From this process, transformational leadership has emerged as a style regarded to positively impact the climate of a school (Allen et al., 2015). Four themes have been identified as evidence of traits of effective school principals: develop and maintain goals and visions, have a positive impact on the school culture, lead systems of distributed leadership, and exhibit traits and qualities of effective leadership (Brown, 2016).

Principals are expected to be facilitators of communication and collaboration (Brown, 2016). This communication and collaboration go beyond traditional school success to include student learning supports and youth development, family engagement, mental health, and opportunities outside school time. These expanded issues are directly emphasized or de-emphasized by the priorities of the school leader. These leader perceptions affect the school climate and the improvement plan (Iachini et al., 2015). Lynch (2016) cited two contradictory studies concerning principal self-reports of their perceived ability to lead the instruction specific for students with special services. One report indicated over 50% of school leaders desired more preparation concerning instruction with special education, and 78% stated they struggled with supporting special education teachers. Another study reported 82% of principals indicated the ability to implement various learning strategies for special-needs students (Lynch, 2016).

Leadership and Instructional Knowledge

Educational leaders place great emphasis on equipping teachers with strategies so students ultimately graduate (Shaughnessy, 2015). Lynch (2016) cited ~~i~~nstructional knowledge of the principal as a critical responsibility to provide effective instruction. Leaders provide information to teachers and focus on approaches to improve student learning and achievement (Shen et al., 2012). As Common Core standards have emerged across the nation, brain and inquiry-based learning has been incorporated into instruction. Leaders and educators in general have been required through accountability to assimilate these instructional frameworks within the standards and emphasize real-world networks and problem solving. Principals committed to this process require teachers to use inquiry-driven and brain-based pedagogy to teach students 21st century skills and Common Core standards (Ratzer, 2014). School leaders and teachers build these skills into the standards, determine teaching strategies used, and use structural teaching and learning approaches. These changes are shaped by principal perceptions of learning, curricular choices, and motivations for change (Kwek, 2011).

Leadership and Perspectives of Teaching and Learning

Despite the importance of leadership in schools, little research has been completed concerning leadership perspectives with teaching and learning. This perspective is vital for understanding the emphasis and influences of the principal and the principal's role in school improvement and student achievement (Iachini et al., 2015). New understandings of how the brain functions are increasingly linked to student achievement (Schachter, 2012); therefore, principals' perspectives are key to understand and determine how perceptions of brain-based learning impede or promote staff instruction and student learning (Iachini et al., 2015).

Years of energy and time have been spent trying to identify and define characteristics of effective leaders in education. Policy makers have spent considerable amounts of money on programs designed to improve leadership skills, but little attention has been given to leader perception and how perceptions influence work behavior (Gaziel, 2003). Gokce, Guney, and Katrinli (2014) studied perceptions of management behavior and found statistical significance on individual commitment to the organization. An increase in perception of positive leadership behaviors also increased the level of commitment to the organization, but the data did not show significance between perception of management behavior and organizational culture (Gokce et al., 2014). Previous studies have examined factors related to achievement and climate, but Urick and Bowers (2014) examined the effects of principal perceptions concerning academic climate and the effect on student achievement. The framework of the study was to understand how interactions of the different perceptions affect school climate and the extent of this effect on student perception of the academic climate. In addition, considerations of influences on student achievement were noted (Urick & Bowers, 2014).

Summary

The purpose of this chapter was to analyze the current literature concerning brain-based learning and perceptions of principals as school leaders. The literature review has presented the history of brain research, addressed brain-based learning in education, noted the professional learning needs for educators regarding neuroscience, determined the importance of brain-based learning with curriculum and instruction, and lastly described the influence and perspectives of the leadership role concerning knowledge of brain-based learning. Brain-based learning has evolved and played an important role in educating students. The process of learning requires educators to understand the foundational brain-based learning principles and incorporate this newer and changing transdisciplinary area into classroom instruction.

Studies have indicated brain-based learning has significant effects on students. Teachers and leaders can use this knowledge as a guide for pedagogy and to understand how the brain works, learns, and remembers. By aligning the learning models used within schools to the foundational understanding of mind, brain, and education science, the natural processes of the brain allow students to maximize learning. Abilities are not fixed but are malleable, and the brain's plasticity is directly developed by neural firing through experiences.

Researchers strongly suggested teacher professional learning include an awareness of certain neuroscientific understanding and findings, debunked neuromyths, and warnings to follow rigorous research-based practices grounded in sound research. Various researchers pointed out the importance of continual work between neuroscientists and educators to improve shared ideas and the implementation of effective and useful knowledge regarding teaching and learning. Individuals learn differently, and brain-based learning supports the implementation of diverse strategies within schools. Researchers concluded there is a need for teachers to understand not only how to teach, but also the significance of understanding how students learn.

Neuroimaging has transformed the understanding of learning processes through neural constructs and pathways and other cognitive skills. The learning cycle was described as well as the impact on educational outcomes of other crucial factors such as memory; emotions; attention; stress; and student, teacher, and leadership beliefs. Minimal research has been conducted on leadership perspectives concerning brain-based learning. Tables 1, 2, 3, and 4 present a summary of literature reviewed on the topics of brain-based learning and the physiology of neuroscience, professional learning needs, curriculum and instruction, and leadership, respectively. The purpose of this study was to determine principals' perceptions of brain-based learning and any impact on instruction at their schools.

Table 1

Studies on the Physiology of Neuroscience

Publication	Type of study and sample	Purpose	Relevant results
Vyas, K., & Vashishtha, K. C. (2013). Effectiveness of teaching based on brain research with reference to academic achievement of secondary school students. *International Journal of Students Research in Technology & Management, 1*, 383-397.	Quasi-experimental, comparison groups; 65 students with comparable previous academic achievement; pre- and posttest method	To compare brain-based teaching modules to traditional lesson plans to determine whether posttest scores were affected	Posttest achievement scores for students receiving the brain-based learning approach were significantly higher than scores of students in the traditional method group.

Table 2

Studies on Professional Learning Needs for Educators Regarding Neuroscience

Publication	Type of study and sample	Purpose	Relevant results
Ross, D., & Cozzens, J. (2016). The principalship: Essential core competencies for instructional leadership and its impact on school climate. *Journal of Education and Training Studies,4*(9), 162-176.	Quantitative; 375 teachers; multiple regression analysis on 13 core competencies	To investigate teachers' perceptions of principals' leadership behaviors that influence the school's climate	Teachers perceived diversity (1 of the 13 competencies), which involves the principal respecting the ideas of others and eliminating biases, had the great impact on school culture. Further, 11 of the 13 competencies were significant.
Kapadia, R. H. (2013). Level of awareness about knowledge, belief and practice of brain based learning of school teachers in greater Mumbai region. *Procedia–Social and Behavioral Sciences, 123,* 97-105.	Quantitative using a descriptive survey method, used a brain-based learning survey	To measure the awareness of brain-based learning among teachers using their practices, beliefs, and knowledge	Teachers did have some knowledge and practiced brain-based learning in their classrooms. Indicated a need for more formal training in brain-based learning; administration should provide the professional learning.
Duman, B. (2010). The effects of brain-based learning on the academic achievement of students with different learning styles. *Educational Sciences: Theory and Practice, 10*, 2077-2103.	Quantitative pre- and posttest using experimental design; Kolb's learning styles inventory and academic achievement tests; 68 students (34 in each group)	To determine differences between the brain-based learning approach and the traditional method using academic pre- and posttests with an experimental and control group; also to determine if learning styles affect achievement levels	Brain-based learning did significantly affect achievement levels of students; no significant difference was found between various learning styles and achievement levels with the experimental group.
Waree, C. (2017). An increasing of primary school teachers' competency in brain-based learning. *International Education Studies, 10*, 176-184.	Quantitative using an experimental group (received training) and control group (no training), measured by a pre- and posttest; 90 teachers	To develop a handbook for competency-based training on brain-based learning management and determine the competency of elementary school teachers pre- and posttraining in brain-based instructional management	A curriculum was developed using competency-based training on brain-based learning management. The experimental group scored higher than the control group and had increased competency.

Table 3

Studies on Curriculum and Instruction and Brain-Based Learning

Publication	Type of study and sample	Purpose	Relevant results
Uzezi, J., & Jonah, K. (2017). Effectiveness of brain-based learning strategy on students' academic achievement, attitude, motivation and knowledge retention in electrochemistry. *Journal of Education, Society and Behavioral Science, 21*(3), 1-13.	Quasi-experimental design, pre- and posttests; experimental group used brain-based learning, and control group used traditional teaching method; data collected through achievement tests and motivation/ attitude scales; 87 students	To determine any differences in achievement test scores between the groups with teaching method, attitude, motivation, and retention of students	Found a significant difference in achievement tests with motivation and attitude
Balim, A. G. (2013). The effect of mind-mapping applications on upper primary students' success and inquiry-learning skills in science and environment education. *International Research in Geographical and Environmental Education, 22*, 337-352.	Quantitative quasi-experimental design with pre- and posttest and a control group; 64 seventh graders with similar achievement levels; study continued for 4 hours a week for 3 weeks	To explore whether mind-mapping techniques used in a science class affected student achievement, determine the students' perceptions of inquiry-based skills, and review retention of knowledge	Achievement pretest averages showed no significance; posttest showed significant difference favoring the experimental group. Perception scale of inquiry learning skills posttests showed significant difference favoring the experimental group. Experimental group retention score increased significantly.
Gulpinar, M., Isoglu-Alkac, U., & Yegen, B. (2015). Integrated and contextual basic science instruction in preclinical education: problem-based learning experience enriched with brain/mind learning principles. *Educational Sciences: Theory & Practice, 15*, 1215-1228.	Mixed methods; 295 medical students; opinions collected (interviews and evaluation forms) about processes and outcomes of problem-based learning program enriched with mind and brain learning principles; used observation forms, document content analysis, participant views; product evaluation study assessed by student achievement exam scores; used Human Information Processing Survey to determine the participants' preferred hemisphere (right, left, or both)	To assess and revise a problem-based learning program; focus on improving materials, learning, to improve the learning environment; reduce metacognitive and cognitive loads to a more feasible level; and determine hemispheric preference	Determined student learning styles and hemispheric preference (59.9% both, 28.9% right, and 11.2% left hemisphere). Found preferences are questionable and need more research to provide evidence. Exam scores increased from 41.1% to 73.9% between the standard problem-based learning program and the program enriched with mind and brain learning principles.

(continues)

Table 3 *(continued)*

Publication	Type of study and sample	Purpose	Relevant results
Gozuyesil, E. & Dikici, A. (2014). The effect of brain based learning on academic achievement: A meta-analytical study. *Educational Sciences: Theory and Practice*, *14*, 642-648.	Quantitative meta-analytical study; 31 studies that included 42 effects	To determine the effectiveness of brain-based learning on achievement level	Brain-based learning methods improved academic achievement more than traditional teaching methods.
Kall, L., Malmgren, H., Olsson, E., Linden, T., & Nilsson, M. (2015). Effects of a curricular physical activity intervention on children's school performance, wellness, and brain activity. *Journal of School Health*, *85*, 704-713.	Quantitative quasi-experimental design with a control and intervention group; all 545 elementary students took national tests; 79 students participated in an oxygen-consumption test and MRI at the control school; data collected from 349 students about health-related quality of life and socioemotional information; 182 students at intervention school and 167 from one control school	To add "School in Motion" to the curriculum in the intervention schools and compare the intervention school to the control school (curriculum not added); also to note comparisons in academic achievement, health-related quality of life (questionnaire), psychological well-being, and the correlates between the brain and physical fitness through MRI scans.	Physical activity in a school's curriculum increased achievement and psychological health, particularly among girls.
Hruska, P., Krigolson, O., Coderre, S., McLaughlin, K., Cortese, F., Doig, C., . . . Hecker, K. (2016). Working memory, reasoning, and expertise in medicine—Insights into their relationship using functional neuroimaging. *Advances in Health Sciences Education*, *21*, 935-952.	Quantitative; 10 medical students (2nd year) and 10 practicing gastrologists; used fMRI to measure neural areas used with difficult and easy scenarios.	To examine the relationship between working memory and reasoning; to determine neural areas used with working memory between the experts and novice participants	Multiple neural areas were activated in both groups. Working memory was utilized more in novice group in both hard and easy scenarios. Neural activations were different, suggesting reasoning and working memory relationship is important. Memory structures were activated differently based on expertise level.

Note. MRI = functional magnetic resonance imaging; fMRI = functional magnetic resonance imaging.

Table 4

Studies on Leadership Influence and Perspective

Publication	Type of study and sample	Purpose	Relevant results
Kwek, S. H. D. (2011). *Innovation in the classroom: Design thinking for 21st century learning* (Master's thesis). Retrieved from https://web.stanford.edu/group/redlab	Qualitative/case study; interviews with three teachers, one principal, and four students; lesson observations	To understand the motivations and considerations that drive teachers to adopt instructional approaches, specifically design thinking	Teachers differentiate usability of design thinking approach through considerations of purpose, learning context and subjects. Core content taught is also a major motivator for teachers. Need for 21st century curriculum and pedagogy beyond foundational content.
Urick, A., & Bowers, A. (2014). The impact of principal perception on student achievement climate and achievement in high school: How does it measure up? *Journal of School Leadership, 24*, 386-414.	Quantitative (two-level hierarchical linear models); Educational Longitudinal Survey: 2002 survey given by the National Center for Education Statistics; 520 public high schools	To understand the between-school variance of student perceptions of academic climate and the effect that the principal's perception of academic climate has on the student perception of academic climate; also to understand the extent that the principals' perceptions of academic climate and their leadership and the students' perceptions of academic climate have on achievement	Principal perception of academic climate had a direct effect on student achievement
Shen, J., Cooley, V., Ma, X., Reeves, P., Burt, W., Rainey, M., & Yuan, W. (2012). Data-informed decision making on high-impact strategies: Developing and validating an instrument for principals. *Journal of Experimental Education, 80*(1), 1-25.	Quantitative; surveys; item analysis; 256 principals	To measure the frequencies of responses to determine the extent principals use data to engage in decision making using 11 high-impact strategies from Marzano	Developed an instrument for principals to use: Data-Informed Decision-Making on High-Impact Strategies: An Inventory for Principals. Instrument enables principals to focus on student achievement by using 11 strategies, use data to improve leadership, connect leadership to student achievement.

(continues)

Table 4 *(continued)*

Publication	Type of study and sample	Purpose	Relevant results
Gaziel, H. (2003). Images of leadership and their effect upon school principals' performance. *International Review of Education, 49*, 475-486.	Mixed methods; qualitative to explore the principal's thinking and how each principal framed their thinking (20 principals); quantitative to measure the relationship between the principal and teachers (60 principal and 300 teachers completed School Leadership Orientation survey)	To identify principal perceptions of their world and determine how teachers perceive the principal's work behavior	Principal perceptions were categorized into four models (structural, human-resource, political, and symbolic model). Best predictors of leadership effectiveness as a manager were structural and human resource models. Best predictor of leadership effectiveness were the political and human resource models.
Gokce, B., Guney, S., & Katrinli, A. (2014). Does doctors' perception of hospital leadership style and organizational culture influence their organizational commitment? *Social Behavior and Personality, 42*, 1549-1562.	Survey of 98 doctors; used a multifactor leadership questionnaire and an organizational commitment scale	To determine to what extent the perceptions of doctors affect organizational commitment and perceptions on organizational culture	Significance between the doctor's perceptions of leadership behavior and their level of commitment, but no significance in organizational culture
Iachini, A., Pitner, R., Morgan, F., & Rhodes, K. (2015). Exploring the principal perspective: Implications for expanded school improvement and school mental health. *Children & Schools, 38*, 40-49.	Mixed methods; 20 principals (survey and phone interviews)	To determine what principals perceive as the greatest needs of students and teachers in school and determine how the perceived areas align with priorities emphasized in the school improvement plans	Principals have a role with the school improvement process, and the perceptions are essential to school improvement. Mental health was specifically identified as an area of importance.

(continues)

Table 4 *(continued)*

Publication	Type of study and sample	Purpose	Relevant results
Allen, N., Grigsby, B., & Peters, M. (2015). Does leadership matter? Examining the relationship among transformational leadership, school climate, and student achievement. *International Journal of Educational Leadership Preparation*, *10*(2), 1-20.	Quantitative correlational study; survey given to six principals and 55 teachers (Multifactor Leadership Questionnaire and School Climate Inventory); student achievement measured using the State of Texas Assessment of Academic Readiness	To measure the relationship between school climate; student achievement in reading and math; and transformational leadership	School climate and leadership: significance between five leadership factors and seven areas in school climate. Student achievement and leadership: Not significant between math and five leadership factors, significant between one leadership factor (inspirational motivation) and reading. Achievement and school climate: not significant between climate and math, significant between school climate areas (order and involvement) and reading. Principal self-assessment and teacher assessment: 2 of 25 correlations significant (principal perception of inspirational motivation and teacher's perception of principal motivation). Correlation between teacher perception of principal's idealized attributes and principal perception of inspirational motivation
Brown, G., III. (2016). Leadership's influence: A case study of an elementary principal's indirect impact on student achievement. *Education*, *137*(1), 101-115.	Qualitative case study; document and analysis of interviews of a principal, six teachers, and two district office administrators (three 1-hour interviews for each group)	To determine the supports provided by the principal in the selected school that increased student achievement	Triangulation process was used and support documented if mentioned by all three groups. The principal provided the following supports: data-driven instruction supported by professional learning communities, school culture including a strong parent organization, school-wide behavior plan with common language between staff and students, scheduled protected learning time, and budget to include needed materials to meet district requirements.
Lynch, J. (2016). Effective instruction for students with disabilities: Perceptions of rural middle school principals. *Rural Special Education Quarterly*, *35*(4), 18-28.	Qualitative; three case studies of principals of middle schools with students with disabilities (interviews)	To determine how principals define effective instruction for students with disabilities and how principals ensure teachers are using effective teaching strategies with students with disabilities	Results indicated principals had a deficiency in understanding when defining effective instruction and did not consistently monitor the implementation effective strategies.

CHAPTER III

METHODOLOGY

The theoretical perspective for this study was based on qualitative research and focused on the interpretations of principals concerning brain-based learning (Merriam & Tisdell, 2016). This chapter describes the methodology used to determine the emergent themes related to brain-based learning that have directly affected the research-based methods and processes that practitioners use daily. The constructivist view relates specifically to this study and illustrates how this understanding is sought (Creswell, 2014). Using the constructivist perspective and a constant comparison approach (Gay & Airasian, 2003), the researcher interpreted these themes and determined how principal perceptions of brain-based learning affect student achievement and overall the education of students. Merriam and Tisdell (2016) defined constant comparative analysis as "comparing one segment of data with another to determine similarities and differences" (p. 32).

The methods used to interpret these findings are described in this chapter, including the research design, research setting and participants, data collection, data analysis, access to participants and the researcher's role, methodological assumptions and limitations, trustworthiness, ethical considerations and procedures, and a summary. This interpretative research was accomplished by using these methods inductively and deductively to analyze data (Creswell, 2014).

Research Questions

Educational research often uses inquiry to gain information about a topic (Gay & Airasian, 2003). A case study through a focus group and individual interviews was used to collect information to elaborate and verify the implications of the perceptions of principals. The findings allowed the researcher to determine principals' experiences, meanings, and behaviors (Bogdan & Biklen, 2007) to answer the research questions:

1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?
2. What are the themes among principals concerning brain-based learning?
3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?

Research Design

The design selected to conduct this study was a bounded case study, as described by Yin (2018). This qualitative design allowed the researcher to obtain the perception of the participants and understand the meaning of their world through their interactions, narratives, behaviors, and understanding of brain-based learning in their schools (Bogdan & Biklen, 2007; Merriam & Tisdell, 2016). The construct for this study was to look for common knowledge among the perceptions of the group to determine any emergent themes (Creswell & Poth, 2018; Saldaña, 2009). By understanding the conversations, feelings, thoughts, beliefs, and values of the participants' experiences and understanding, direct accounts were collected through individual and focus group interviews (Gay & Airasian, 2003). This dialogue encouraged and permitted ideas, feelings, and images to be shared through the quest for natural expression through the framework of the participants (Moustakas, 1990), providing richly descriptive data (Merriam & Tisdell, 2016).

Yin (2018) defined a case study as an empirical approach to investigate a phenomenon through in-depth and real-world content through several sources of data to answer the why and how of the investigation. This case study compares units of analysis through a bounded system to explore the phenomenon (Creswell & Poth, 2018; Merriam & Tisdell, 2016). The individuals in this research were the entities, or case, bounded in single units. Their collective individual knowledge was the case example and provided detailed descriptions and analysis of the bounded system (Merriam & Tisdell, 2016). The study provided information that was chronicled, interpreted, and evaluated through the inquiry research approach (Bogdan & Biklen, 2007). The researcher used active engagement through the interviews to obtain meaningful and quality interactions. This helped maintain an appropriate balance and allowed the investigator to gain full understanding of the participants (Lincoln & Guba, 1985).

For this study, the objective was to capture the conditions and circumstances in a school setting to provide the researcher with answers to the three research questions. In this bounded case structure, the researcher used a focus group and individual interviews that included elementary principals in one Georgia county to collect information concerning relevant concepts related to perceptions and relationships to brain-based learning in the principals' schools. Through these methods, themes were identified (Yin, 2018) that described multiple perspectives and identified the factors pertinent to instruction and brain-based learning.

Research Setting and Participants

Research Setting

The setting for this research study was a county in middle Georgia. According to the U.S. Census Bureau (2018), the county population was 155,469 with 25.7% under the age of 18. The average household income in 2018 was $55,965, and 13% lived in poverty. According to the Governor's Office of Student Achievement (2018), the county's student enrollment was 29,770, served by 23 elementary schools, nine middle schools, and six high schools. This study only included elementary schools. The graduation rate for all students was 87.2%; the Advanced Placement student graduation rate was 98.9%; and Career, Technical, and Agricultural Education completers' graduation rate was 98%. The Board of Education county webpage in 2018 displayed several facts concerning the demographic population, school, and county. The county district had a 14:1 pupil-to-teacher ratio, and the demographics were as follows: 42.9% White or European American, 38.4% Black or African American, 9.65% Hispanic, 2.62% Asian, 6.26% multiracial, and 0.17% American Indian.

A credentialed individual trained in interviewing performed the interviews for both the focus group and the four additional individual interviews. The focus group of 12 participants took place at the end of the day in the media center at the researcher's school in the center of the county. Participants were informed that the session was being recorded, all names would be kept confidential and pseudonyms given, there were no rewards, and participation was strictly voluntary. Anyone who wished to leave was allowed without any negative consequences.

This site was selected because it was easy for the individuals to locate and attend. This setting was appropriate because the meeting took place in a private location after the close of the school day. Do not disturb signs were posted to prevent interruptions, and the interviewer and participants sat in an area of the media center where no one could see the group from the windows of the room.

The individual interview sessions took place at the four individual participants' schools. Each interview convened in a location selected by the individual school principal within the school building. The interviewee selected the location because he or she was most familiar with the school campus. The specific interview was held in a private room at the end of the school day. This one-on-one encounter allowed for additional conversations that enriched the data through the thoughts and perceptions of the principals (Merriam & Tisdell, 2016).

Selection of Participants

Before beginning the research, the researcher determined the method of participant selection. The researcher considered where, what, whom, and when to gather the data (Merriam & Tisdell, 2016). According to Gay and Airasian (2003), purposive sampling is "selecting a number of individuals for a study in such a way that the individuals represent the larger group from which they were selected" (p. 116). Creswell (2014) posited that purposive sampling is often used in qualitative research because the inquirer designates participants for the purpose of understanding the guided questions and determining the phenomenon with the research. When selecting participants, the researcher determined whether the sampling gave the necessary information for the collection of data (Creswell & Poth, 2018).

Various types of purposive sampling are used in qualitative research, such as homogeneous, criterion, snowball, intensity, and random and stratified purposive sampling. For this study, the investigator used stratified purposeful sampling (Creswell & Poth, 2018). Purposeful sampling was selected to facilitate the analytic induction of knowledge (Bogdan & Biklen, 2007) and naturalistic inquiry (Lincoln & Guba, 1985). Using this sampling method, the researcher selected principals to facilitate the development of the constructivist view (Bogdan & Biklen, 2007) and gained knowledge of the perceptions of each principal within the sampling (Gay & Airasian, 2003).

The county has 23 elementary schools. The researcher made contact with all 23 principals and selected 12 to participate based on gender and ethnicity through stratified sampling (Gay & Airasian, 2003). This selection process helped ensure sampling bias did not occur and served as a reliable representation of the population. All 23 principals met the purposive criteria for the research design based on their titles and knowledge. By asking all elementary schools, participation was offered to all 23 principals within the county, and the researcher increased the immersion within the setting and increased the depth of the inquiry and context (Gay & Airasian, 2003). The sample size of 12 allowed the researcher to work with a reasonable number of participants, collect data in a natural setting, and provide adequate data to analyze (Creswell, 2014).

Of the 12 principals, six were White females, two were Black females, and two were White males. Seven held doctoral degrees, and the remaining five principals held specialist degrees. The average elementary school enrollment for the 12 selected schools was 624. The sample size of principals was conducive to varied demographics by gender and race and included leaders of five Title I and seven non-Title I schools. A limitation of this study is participant gender and race. Neither Hispanic principals nor Black male principals were represented.

The researcher already had rapport with the individuals participating because of employment in the same county. Due to the current relationships with the principals in the selected county, another trained individual (see Appendix H) conducted the focus group and individual interview sessions. Four principals from both Title I and non-Title I schools were individually interviewed. These additional individual interviews were held after the completion of the focus group to expand and gain a richer description of the guiding questions. Having two interview sessions established reliability and construct validity and triangulated the data (Yin, 2018).

Data Collection

Merriam and Tisdell (2016) defined data as "ordinary bits and pieces of information found in the environment" (p. 105). The interviewer was the main instrument for the collection of the data, and the researcher was the main instrument for data analysis. Verbal descriptions were recorded throughout the focus group interviews and additional individual interviews. Qualitative methods require the information collected and interpreted to rely on and capture the human meaning of the participants as the phenomenon has been experienced and understood (Gay & Airasian, 2003). Lincoln and Guba (1985) contended triangulation is a vital step when collecting data. The data for this case study included interview anecdotal notes, field notes, audio recordings, verbatim transcriptions, and e-mails. To assure credibility, the investigator used the constant comparison method while completing the interviews in both settings. The individual interviews served as an additional method to validate and enhance the collected information from the focus group interviews (Lincoln & Guba, 1985).

Table 5

Focus Group and Interview Questions Blueprint

	Number of items	
Research question	Focus group	Interview
1. Principal perception of brain-based learning and instruction	6	6
2. Principal themes of brain-based learning	11	9
3. Principal relationships/emphasis with brain-based learning	6	5

Interviews

Qualitative research often includes collecting data through observations, interviews, documents, and audiovisual materials (Creswell & Poth, 2018). For this study, the researcher chose interviews. Merriam and Tisdell (2016) stated interviews may be structured, semi-structured, partially structured, or unstructured; however, the researcher selected the semi-structured approach, which ensured that all questions were asked and allowed for follow-up questions. Creswell and Poth (2018) suggested following a series of steps when using interviews:

1. Use purposeful sampling.
2. Select a type of interview method that will best answer the research questions and use appropriate recording procedures.
3. Develop adequate questions and pilot the questions before the actual interview.
4. Plan a setting appropriate for interviewing that is distraction and noise free.

5. Obtain consent before beginning the interview.
6. Ensure a suitable amount of time and follow the questions.

Before the focus group and individual interviews for this case study began, the researcher established interview concessions (Creswell, 2014). The researcher employed two interview approaches in this study. The first approach to gain information was through a focus group and included 11 semi-structured questions (see Appendix E). A panel of experts deemed the questions for the focus group transferrable and reliable. These experts were Georgia principals who examined and analyzed each query. Furthermore, the questions were aligned to the three research questions:

Research Question 1: What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?

Research Question 2: What are the themes among principals concerning brain-based learning?

Research Question 3: What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?

The individual interview sessions lasted approximately 45 minutes. The questions were open ended and carefully crafted (Moustakas, 1990) to be flexible; a semi-structured protocol was used to gain rich and descriptive knowledge from each principal (Merriam & Tisdell, 2016). This interview session included nine semi-structured questions based on answers from the focus group interview session to extend and gain richer meaning (see Appendix G). The questions included the necessary elements of interviewing: descriptive, structural, and contrasting questions (Spradley,

1980) in order to explore the guiding questions more and gain additional knowledge (Merriam & Tisdell, 2016).

All interview sessions were scheduled at the end of a regular school day and were expected to last 45 to 60 minutes. Before the focus group and individual interviews began, each participant received and signed a consent form (see Appendices D and F, respectively). The form explained the purpose and expectations, informed participants that the meeting was strictly voluntary, and stated all identifying information shared would be kept confidential and locked in a safe or password-protected computer for 3 years. Furthermore, no gifts, tokens, or rewards were provided by the researcher (Mack et al., 2005). The researcher did not provide any materials for the informants at any time during the interview. All focus group questions were answered by taking turns within the group based on free-flowing answers from the participants (Spradley, 1980). Furthermore, no specific questions were given to specific principals at the time the focus group met.

The interviewer gathered detailed knowledge of brain-based learning through the focus group and individual interview sessions (Merriam & Tisdell, 2016). This moderator alone asked the questions and recorded the responses. In addition, only the moderator completing the interviews had possession of the questions during the interviews and took anecdotal notes on a laptop while answers were being given. Gay and Airasian (2003) asserted the importance of accurate recording when observing. The interviewer asked all the questions, used an audio recording at the time of the interview, and took notes on the laptop (Spradley, 1980). Due to the complexity of human notetaking, an Olympus W5-852 digital voice recorder was used to ensure reactive responses, inflections, and other observable traits were documented when replaying the recording (Gay & Airasian, 2003). The investigator's laptop had recording capabilities and was used as a backup device for recording.

A professional stenographer transcribed each interview verbatim. The researcher contacted the stenographer via a phone call before the interviews and explained the study and expectations for the transcription. The researcher used Dropbox to deliver the recordings. A week was estimated to be an acceptable amount of time for the stenographer to finish transcribing the recordings. The stenographer e-mailed the transcriptions to the researcher.

To maintain confidentiality, pseudonyms were assigned to each participant. Before speaking during the interview, each participant self-identified using the assigned pseudonym. This recorded statement allowed the researcher and stenographer to identify the speaker.

Documents

Case study qualitative research is strengthened through documentation of methods (Merriam & Tisdell, 2016). Qualitative research requires a process of documentation to follow inquiry-based methods (Bogdan & Biklen, 2007). The documentation for this study included dialogue to investigate and review the thoughts, feelings, ideas, and images expressed by the participants (Moustakas, 1990). A bibliography of the documents collected was annotated to serve as an index for later retrieval and review. Furthermore, the evidence exhibited increased the study's quality, assisted the researcher and other interested parties with review, reflected the construct validity, and provided evidence to answer the research questions for the study (Yin, 2018).

All physical documents will be locked in a secure safe for 3 years. At the end of the 3 years, the documents will be destroyed by shredding. All electronic files will be kept on a password-secured device. At the end of the 3 years, the electronic documents will be destroyed through Secure Erase.

Data Analysis

The case study was exploratory in nature. The questions were based on themes from literature (Johnson & Christensen, 2017) concerning brain-based learning and the guiding research questions from the study. Qualitative research requires the researcher to be engaged with the participants throughout the study (Creswell, 2014). During the analysis phase, the researcher reviewed and reflected on the rich and deep data searching for the understandings and perspectives of the principals (Moustakas, 1990). Qualitative research has several characteristics to be considered when beginning the analysis phase (Gay & Airasian, 2003). Gay and Airasian (2003) posited seven characteristics to recognize:

- To know something takes more than one way.
- Reporting the data is done more than one way.
- Messages do not contain neutrality.
- Language develops the reality of the study.
- The researcher interacts profoundly with the data.
- Cognition and affect are indistinguishably united.
- Social reality is not linear, fixed, or neat.

The purpose of the analysis process was to gain high-quality results and findings. Before beginning the analytic development, general strategies needed for the particular study were determined. Yin (2018) suggested five techniques to review:

1. Pattern matching is comparing a predicted pattern with the empirical pattern. Pattern matching, when concepts are similar, specifically strengthens the study and provides internal validity. If the patterns do not match, the data are reviewed differently from the original prediction. The why and how of the themes draw conclusions of explanations. The case study grows stronger as precise measures are developed (Yin, 2018).
2. Explanation building relates causal effects to outcomes. Typically, this technique is completed in narrative form. Initial statements are compared, revised, contrasted, and repeated as needed (Yin, 2018).
3. Time-series analyzation involves reviewing relevant measures over time. Changes are traced with detail and may strengthen the case. The empirical trend and the theoretical or a rival trend are matched and are often compiled in a chronological sequence (Yin, 2018).
4. Logic models reveal an operational model of repeated cause-and-effect patterns. These models are especially useful when determining how a program works. Interventions lead to initial outcomes and then final outcomes (Yin, 2018).
5. Cross-case synthesis identifies fundamental variables and cross-checks the data for individual variables. The goal is to retain the purity of the case and later synthesize any other patterns found within the case or cases (Yin, 2018).

The researcher used pattern matching to begin coding. Creswell (2014) suggested coding is an organization process of bracketing chunks of text and placing the text in a category. As the organization developed, the investigator determined main topics based on the interview `session transcriptions. The review of the documents continued as increasing codes or groups emerged (Creswell, 2014) to build explanations, review relevant measure, and establish logic models (Yin, 2018). A table was used to help with the placement of text and retainment of categorical meaning (Creswell, 2014). By tabulating the coding results of text, the researcher developed a systematic manner to compare and synthesize the results of principal perceptions (Bogdan & Biklen, 2007).

The analysis process included actions in order to tell the story of the data (Lincoln & Guba, 1985). The researcher used hand coding and sequenced the transcriptions, notes, and other documentation together in a comprehensible manner from each participant until patterns emerged. The process required several weeks until core themes and patterns were determined to answer the guiding questions (Moustakas, 1990). Coding categories were developed to sort codes of data according to an organized scheme and system. These units of data were reviewed numerous times, beginning with separation by the most general topics and categories. These categories were continually noted and assigned to assist the researcher with the interpretation and analysis process (Bogdan & Biklen, 2007). Once the categories were completed and the descriptive text organized, the researcher had an understanding of the essential themes and qualities of the dossier and could depict the individuals' responses from both the focus group and the additional individual interview sessions (see Moustakas, 1990).

Qualitative research includes stages throughout the collection of the data, and decisions are made throughout the entire fieldwork (Moustakas, 1990). Narrative inquiry was the basis for the analysis process in this case study (Yin, 2018). This approach allowed the researcher to view the text and witness how the principals interacted, how they understood brain-based learning, and how this understanding affected their individual schools. The analysis process predominately involved the constant comparative design (Merriam & Tisdell, 2016). This process was ongoing and inductive and continued until the end of data collection (Moustakas, 1990).

Negotiating Access

Initial approval was received through the researcher's county (see Appendix B), but additional approval was necessary through the Columbus State University IRB (see Appendix A). Both institutions determined when the researcher had access to the participants and when the actual research began (Creswell, 2014). The interest and the explanation for the study were explained to those at the highest level of each organization. After access was gained, the investigator was allowed to proceed with the study. Principals also had to give permission (Bogdan & Biklen, 2007). The participants were originally recruited via e-mails asking for their participation and consent to be included in the study (see Appendix C). The researcher explained the purpose of the interview. The 12 participants were interviewed as a focus group, and four principals were asked to participate in individual interviews for this case study. The focus group interview took place at the researcher's school because the school is located in the center of the county. The individual interviews took place at the participants' schools.

Researcher's Role

In any study, especially qualitative research, when the researcher is often the sole investigator, bias occurs naturally and unintentionally (Bogdan & Biklen, 2007). The role of the researcher is to explain the accounts of the entire study for others, but the researcher needs to understand the specifics and entirety of all elements throughout the process (Gay & Airasian, 2003). Case studies specifically require the researcher to make judgement calls (Yin, 2018). In this study, the researcher is a principal in the county where the study was conducted and had a direct connection with the research. To reduce bias and persuasion, the researcher appointed an interviewer for this case study. In this case, the researcher was a main stakeholder in the research process; therefore, the researcher was not used in the data collection (Gay & Airasian, 2003). Based on the collection of findings, the researcher will use the information to improve the instruction and learning at the researcher's current school.

Educational research often uses inquiry to gain information about a topic (Gay & Airasian, 2003). By integrating and synthesizing the concepts into relationships, analysis occurs (Creswell, 2014). The bias occurs because the researcher has connections, linkages, and common aspects going into the study (Gay & Airasian, 2003). Through this process, the investigator sought to engage other principals to understand how the participants interpret and make meaning of brain-based learning in their workplace. Through their engagement, multiple forms of data were analyzed and synthesized by the researcher through interview data. This systematic activity allowed the qualitative research to occur and gain insights that otherwise would not have been noted through quantitative studies (Merriam & Tisdell, 2106).

Methodological Assumptions

The methodology for this study was derived from a naturalistic inquiry approach with certain limitations and assumptions (Moustakas, 1990). The context required a human instrument in order to deeply understand the perceptions of the participants and follow the patterns and development of the documentation (Bogdan & Biklen, 2007). The demands required an understanding of the bias of the researcher and methods that could be implemented through interviews and document analysis. The premise for the research was to follow a development of inductive thinking, which required continual emergence of inquiry and interpretations to report a case study (Lincoln & Guba, 1985). The ultimate goal for the entire study was to answer the guiding questions based on the framework of understanding the importance of the data. The implications of qualitative research focus on the context and participants. The researcher's interpretative abilities were ultimately personal, hence the importance of following a guide, which included a set of procedures and strategies when interpreting data to eliminate researcher bias. By linking and sequencing patterns until integration and interrelation were evident, the researcher was able to derive meaning and make sense of current and future work (Gay & Airasian, 2003).

Trustworthiness

Research requires thoughtful planning and details to demonstrate trustworthiness. Lincoln and Guba (1985) referred to trustworthiness as measures employed during the inquiry process to increase the probability that data are provided to reach a judgment or an achieved level of integrity within the study. To achieve this level of assurance, the documents had to have a reasonable amount of information, the researcher implemented safeguards to ensure methodology was properly followed, interactions allowed for input, pieces of data were triangulated, materials were archived, the researcher debriefed findings with another individual, and records were maintained for examination (Lincoln & Guba, 1985). Following rigorous procedures and standards developed trustworthiness through credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Merriam & Tisdell, 2016).

Credibility

Credibility in qualitative research is established using a continuum for the fluidity of trustworthiness through the research process (Gay & Airasian, 2003). This process provides internal validity and an interconnectedness with the construction and application of research methods even when using human interpretation. In addition, the study may resonate with varying audiences (Gay & Airasian, 2003; Merriam & Tisdell, 2016). To increase credibility, a second session of interviews was held. This discussion included four of the same participants from the focus group to bolster credibility and extend the descriptive data (Bogdan & Biklen, 2007). These steps indicated credibility through congruency between the concepts described and the selected data (Gay & Airasian, 2003).

Transferability

The transferability of the study required generalizing results to diversified contexts. Transferable results are interchangeable between the current study and other similar locations of populations (Gay & Airasian, 2003). The researcher provided archived data to sustain transferability decision making by others (Lincoln & Guba, 1985) when applied to other contexts or populations (Gay & Airasian, 2003).

Dependability

The dependability of this study developed from credibility, validity, and reliability. Qualitative researchers should demonstrate quality with the process and work of the investigator, participants, and any data used (Merriam & Tisdell, 2016). Lincoln and Guba (1985) suggested several techniques to establish trustworthiness through dependability. One technique is the overlap method, which is a form of triangulation. Another technique is stepwise replication. This technique involves two teams or people that are part of the inquiry, but the data and inquiries are separate. Lincoln and Guba did not always recommend this approach to prove trustworthiness, and it was not used in this study. Lastly, the inquiry audit establishes dependability. The auditor in this case authenticates the work of the researcher. The process is reviewed, and the auditor establishes the study's dependability (Lincoln & Guba, 1985). The investigator met with and had a dissertation committee review for the entire methodology of the research to prove dependability. In addition, the investigator previously referred to numerous other studies to ensure scholarly quality.

Confirmability

Lincoln and Guba (1985) recommended the confirmability audit to establish trustworthiness. To perform an audit for confirmability, specific items and the specific steps for the audit were predetermined. Records of the documentation were reviewed, and the exact audit techniques were documented. Raw data, analysis products, steps for the reconstruction of data and reports, methodology or any process notes, documents of dispositions and intentions, and instrumentation provided the evidence (Lincoln & Guba, 1985). Additionally, this audit included a consideration for researcher bias and use of an interviewer to perform all interview sessions. By thoroughly combing the data, rigor was established (Creswell & Poth, 2018).

Ethical Considerations and Procedures

Ethical Considerations

In any study, the researcher must consider the code of ethics for all participants, including the investigator. Professional conduct is always expected and considered early in a study to avoid and address any dilemmas and issues that arise (Creswell, 2014). Bogdan and Biklen (2007) suggested gaining an informed consent and verifying the informants are free from harm. One method for assuring ethical practice was the application of the IRB. This board was located at the researcher's university and was responsible for rigorously reviewing the proposal for safety and consent (Bogdan & Biklen, 2007). In addition, before any research took place, the researcher's school system required a rigorous review of all aspects of the study. By attaining approval from both institutions, the moral position, safety, and ethical principles were deemed to be in place.

The current study engaged the participants as essential members of the study. Their voice was ultimately the primary research data, so the participants needed to understand the framework for the entire study and that the research was founded in ethical and professional principles (Creswell, 2014; Creswell & Poth, 2018). By being proactive, the researcher was aware of the expected behavior; trained the interviewer to conduct the interviews; and was ethical and sensitive to the participants, data, and the entire process (Yin, 2018). To conduct a study in an ethical manner, the investigator established conditions and considered supportive and contradictory evidence.

Furthermore, the researcher garnered knowledge with relative studies, ensured credibility and accuracy, and addressed methodological limitations and processes (Yin, 2018).

Procedures

Focus group interviews. Members of the case study focus group shared their experiences. Answers to the focus group interview questions indicated principals' experiences and meanings (Moustakas, 1990). The researcher did not anticipate needing to ask additional questions beyond the focus group questions developed because the protocol was validated by a panel. The focus group interview was semi-structured with open-ended questions (see Appendix E). The interviewer read aloud the questions and audio recorded responses, also taking anecdotal notes. During the focus group, 11 questions were asked and later coded based on participant responses. Only one focus group interview session was completed because enough information was gleaned from the session (Chandler & Baldwin, 2010).

The researcher asked all elementary principals to participate in the case study focus group. First, an e-mail was sent to each principal asking for participation (see Appendix C). The e-mail explained the purpose for the focus group interview; the research questions that guided the study; and the suggested location, time, and date for the focus group. A consent form was attached to the e-mail (see Appendix D). If the principal voluntarily elected to participate, the consent form was completed and returned via e-mail back to the researcher. The researcher also had copies of the consent form at the focus group session. In addition, information regarding the selective criteria for joining the focus group and where it would take place was offered at the conclusion of the e-mail conversation.

The interview with the focus group took place at the researcher's school and lasted around 90 minutes. The interviewer explained the interview protocol, asked participants to speak loudly, and gave them their pseudonyms. Moreover, breaks were offered twice during the session. The interviewer asked the participants to respond to 11 questions (see Appendix E) to determine principals' definitions and examples of brain-based learning, brain-based learning at their schools, their role in regard to brain-based learning activities and the impact of student performance, the types of strategies used, how practitioners apply scientific knowledge in the classroom, teacher professional development, and how brain-based learning influences student performance.

After the focus group interview session, a professional transcribed the recording of the interview. The researcher analyzed the interview recordings and transcriptions to note any variance in perception of brain-based learning (Chandler & Baldwin, 2010) and establish themes from the data (Zenkov & Harmon, 2009) to understand any connections made concerning brain-based learning.

Individual interviews. Through the coding process, the researcher selected four additional participants through an intensity sampling method (Gay & Airasian, 2003) based on the need for supplemental evidence. By focusing on four individual principals through one-on-one interviews, the researcher gained key information needed to answer the research questions and gather richer pieces of data (Bogdan & Biklen, 2007).

The investigator approached four of the participants by phone to set up additional one-on-one interviews to collect information. Participants were asked, "Would you be willing to take part in an additional interview to continue with the conversation about brain-based learning?" The individual interviews took place at each principal's school building and took around an hour. The interviewer followed the same protocol as with the focus group by asking principals to participate and explaining the rationale and reason for the additional interviews (see Appendix F). During the interview conversations, participants were asked to speak loudly and give their same pseudonym. Moreover, breaks were offered twice during the session. The interviewer asked the participants to respond to nine questions that allowed for a deeper and more specific response based on the emerging themes from the focus group (see Appendix G).

Focus group and interview data analysis. The answers to the focus group and individual interview questions were transcribed. Data were codes and put into categories and emergent themes. Hughes and DuMont (1993) suggested three types of categories: descriptive, story, and abstract. For this study, the researcher collected the descriptive statements and story statements as needed because the intention was to determine the perceptions of the principals (Spradley, 1980). The researcher noted patterns from the participants' responses (Spradley, 1980) regarding brain-based learning, their values of this discipline, and the impact of student achievement of instruction using brain-based learning principles. By coding the statements collected from the focus group and the additional individual interviews, the researcher answered the three guiding questions and determined the pattern coding (Miles & Huberman, 1984) to connect the descriptive statements (Hughes & DuMont, 1993).

Documents. All documents were examined by the researcher and the university dissertation committee. The only other people granted access to the data during the study were the interviewer (see Appendix H) and stenographer for the purpose of transcription. Member checking was afforded to the individual interviewees to ensure validity in the major themes found (Creswell, 2014). Likewise, the researcher made all documents available for the participants to review at the end of the study.

Summary

This case study measured principals' knowledge, beliefs, and other information concerning brain-based learning. This information assisted in determining and constructing new understanding of the relationship between the principal and mind, brain, and education themes that affect student learning. The guiding questions allowed the researcher to develop a theory and make recommendations for the discipline of brain-based learning in schools. These answers concluded outcomes of this study and offered recommendations for further research.

CHAPTER IV

RESULTS

Overview

The purpose of this study was to determine the association between the principals' perceptions of brain-based learning and the instruction at their schools. This study began with Chapter I, which introduced the changes in education over time; the merge of education, psychology, and neuroscience; the statement of the research problem, the foundational research questions; the conceptual framework for the study; the significance of the study; the procedures; limitations; and delimitations. Relative studies were reviewed in Chapter II in the literature review. This review provided the foundation throughout the research study. The review of literature covered the history of the mind and brain, the physiology of neuroscience, brain-based learning as it relates to education, curriculum and instruction as related to brain-based learning, the professional learning needs for educators regarding neuroscience, and the influence and perspective of leadership in the schools. This literature review identified a gap in the literature regarding principals' perceptions of brain-based learning and the relationship between this perception and the emphasis of brain-based learning in the school building. Chapter III included the methodology for the study and reviewed the theoretical framework, research questions, design, setting and participants, data collection and analysis, how access was negotiated for the study, the researcher's role, methodological assumptions, trustworthiness, ethical considerations, and procedures for the study.

Chapter IV provides the findings of the research. The three research questions were the elemental basis for this entire chapter. To address the literature gap, the researcher designed a study that included a qualitative case study and determined principals' perceptions of brain-based learning. The researcher's knowledge of the elements of mind, brain, and education science was useful in determining the patterns found between principals and the impact the leaders' perceptions of brain-based learning had on instructional practices at their schools. The results indicated principals' perceptions do directly affect the implementation of brain-based education.

Once approval was granted from the researcher's county of employment and the IRB at Columbus State University (see Appendix A), the researcher was able to contact and recruit the participants. Purposive sampling was used because the inquirer designates participants for the purpose of understanding the guiding questions and determines the phenomenon with the research (Creswell & Poth, 2018). Sampling principals allowed the researcher to develop the constructivist view (Bogdan & Biklen, 2007) and gain knowledge of the principals' perceptions (Gay & Airasian, 2003). These themes are presented in Chapter IV, which is organized according to the following elements: research questions, researcher design, participants, findings and data analysis, and results.

Research Questions

1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?
2. What are the themes among principals concerning brain-based learning?
3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?

Research Design

The research methods included a qualitative design to collect data through a focus group and individual interviews through a bounded case study (Yin, 2018). The researcher obtained the participants' shared perceptions and understandings of brain-based learning and the implications of brain-based learning within their schools. Interviews were selected as a method of collecting data to allow the participants to share their understanding of brain-based learning in relation to curriculum and instruction, instructional activities, professional learning, the principal's role, student performance, and the use of brain-based learning in their buildings. The researcher gained data through conversations that included the participants' beliefs, values, thoughts, and feelings (Gay & Airasian, 2003).

All 23 principals in the county were asked via e-mail to participate in the study, and 12 were selected from a stratified sampling based on gender and ethnicity (Gay & Airasian, 2003). The 12 selected were deemed to be a reliable representation of the elementary principal population in the county. The participants also met the criteria for the research design based on their title and knowledge and represented the larger group of the principal population. All participants completed an informed consent and were notified the interview session would be recorded, all names would be kept confidential and pseudonyms would be given, participation was strictly voluntary, and no rewards would be given. Participants could withdraw at any time, if they wished, and had the right to check the transcriptions prior to going forward with publication.

Because the researcher already had rapport with the participants due to employment in the same county, a credentialed individual trained in interviewing performed the interviews for both the focus group and the additional four individual interviews. The focus group took place at the researcher's school in a secure location after the close of the school day at 5:00 p.m. The second interview session took place at the four individual participants' schools. The participants selected the location at school that was most convenient and comfortable for them. Elton selected his office, and the interview began at 4:05 p.m. Liza selected a conference room, and the interview began at 2:33 p.m. Anna selected her office, and the interview began at 8:38 a.m. Lastly, Willis selected his office, and the interview began at 4:34 p.m.

The case study relied on the qualitative method and required the information to be collected and interpreted to capture and rely on the meaning of the participants based on their knowledge and understanding of their experiences (Merriam & Tisdell, 2016). Data from these 12 principals resulted in rich immersion, and the theoretical framework of practice, perceptions, and theories was used to analyze the data with the Glaser and Strauss (1967) constant comparative approach. Multiple forms of data were analyzed, which included interview transcripts, field notes, and e-mail correspondence. The researcher used NVivo (QSR International, 2018) data analysis software and a stenographer to transcribe the interview recordings.

After the transcription was completed, the researcher began noting first impressions when reading through the text. The qualitative research for this study involved establishing meaning from the views of the participants (Creswell, 2014). In addition, the goals for the study, conceptual framework, methods, and validity were tied to the guiding research questions. Next, labels of relevant words were coded for patterns. These repetitive patterns were put into categories and subcategories to find various concepts, language, theories, and constructs (Saldaña, 2009). The data sources were continually compared until categories were determined. Through this process, relative importance, relationships, and key points and themes were interpreted. This content analysis (Taylor-Powell & Renner, 2003) involved the constant comparative design through hand coding to analyze and use narrative inquiry to determine the description of the interview text. This process allowed the researcher to answer the research questions by determining how the principals understood brain-based learning and how effective it was in their individual schools (Merriam & Tisdell, 2016).

Participants

All 23 acting elementary principals in the researcher's county received an invitation via the researcher's home e-mail to participate in the research study. Twelve of the principals were selected based on gender and ethnicity. These 12 principals were provided with a consent form that indicated the time, date, and location for the focus group interview session. Each participant was given a pseudonym for confidentiality and identification during the interview in an attempt to protect the identity of the participant. Participant demographics are shown in Table 6.

The participants were selected to represent a good cross-section of the county's current principal population, as shown in Table 6. Seven of the schools are Title I schools. The principals who elected to participate in the study had an average of 7.2 years of administrative experience and 23 years total in the educational field. Only one of the participants had been principal in more than one school setting.

Table 6

Participant Demographics

Pseudonym	Gender	Race	School is Title I or not	Highest education	Years of experience	Years of experience as principal
Elton	Male	White	Not	EdD	24	12
Anna	Female	White	Title I	EdD	28	15
Rachel	Female	White	Title I	Specialist	19	2
Lilly	Female	White	Not	Specialist	28	11
Willis	Male	White	Not	Specialist	21	5
Crystal	Female	Black	Title I	EdD	27	10
Charlotte	Female	White	Not	EdD	21	12
Gail	Female	Black	Title I	Specialist	21	3
Olivia	Female	Black	Not	EdD	21	5
Liza	Female	Black	Title I	Specialist	26	5
Vanessa	Female	White	Not	EdD	27	4
Cathy	Female	White	Not	PhD	13	2

Elton

Elton began his educational career as a band director at a high school for 1 year, then became a middle school band director 3 years, and back to a high school band director for 6 years. After his time as a band director he became the assistant principal of instruction at the elementary level for 2 years and then became a principal. He has been principal at one school for 7 years and then opened up a new school where he has served for the last 5 years. He is nationally certified as a mentor principal and has served on the Handbook Committee and the Evaluation Committee in his county. Currently, he is the president of a state leadership group, has worked with legislators on behalf of public education, and serves as an adjunct professor. He received the Georgia Association of Elementary School Principals outstanding educator award and service award. Lastly, he received the 2019 Georgia Distinguished Principal award, and his school won the School Bell Award.

Anna

Anna began her education career in 1991 teaching second grade. In 1998, she began teaching fourth grade and in 1999 started her administrative career as assistant principal of instruction. During her educational career, she has been awarded Teacher of the Year, received certification as a principal mentor, recognized as a state Distinguished Principal twice, and also received national recognition as a Distinguished Principal. She has also served on numerous committees, including her county Leadership Academy; presented at leadership conferences such as the Georgia Association of Elementary School Principals and the New Principal Mentor Program; and is currently on the Professional Learning Community Taskforce committee for her county. The school she leads has also been named a Title I Reward School and received Georgia STEM school status.

Rachel

Rachel has taught kindergarten and first, third, and fifth grades at two elementary schools since 2000. She began teaching at the age of 40. Before finishing college at 40, she worked as a secretary and at a newspaper company, along with several other small jobs. During her educational career she has served as a grade-level chair, been a part of the leadership team, and worked on the Better Seeking Team. She has been a principal for 2 years at one school.

Lilly

Lilly began her career in education 29 years prior to the study, in 1990. She started in kindergarten and taught at that level for 5 years. Then, she trained to be Reading Recovery teacher and began serving students in the Early Intervention Program. During this time, she also cotaught first grade. She decided to get training as a Literacy Coordinator. After this training, she taught second grade for half the day and then coached teachers the second half of the day. She changed schools and became a full-time literacy coach for 3 years. She became an assistant principal of instruction in 2005 and then principal at the same school in 2008. During her educational career she has been nominated for Teacher of the Year twice and has served on different leadership teams.

Willis

Willis began teaching as an English teacher at the high school level in 1997. He became a high school assistant principal in 2005 and in 2013 became a principal at the elementary level. He serves as an officer for a state leadership association. His school is also a top-performing school in the county.

Crystal

Crystal served as a police officer until starting her educational career in 1992, when she became a middle school teacher. After 12 years of teaching, she served as an assistant principal of discipline at three elementary schools and has been a principal for 10 years. She is a member of the Multi-Tier System of Supports Committee and Georgia Association of Elementary School Principals, where she served as the treasurer and secretary for her district. She is also a member of the National Association of Elementary School Principals and the Georgia Association of Educators. Her awards include Teacher of the Year at two schools, county Teacher of the Year, and the Georgia Association of Elementary School Principals Professional of the Year.

Charlotte

Charlotte started her career after college as a flight attendant. She continued this path until she came to understand that education was her true calling. In 1998, she became a teacher and taught kindergarten, second, and third grades. She became an assistant principal of instruction and has served as a principal since 2007. As a principal, her school has received numerous high student achievement awards and was nominated as Best of the Best twice. She is an officer for a state leadership association, a principal mentor, on a dissertation committee at Piedmont College, and a local federal credit union board member.

Gail

Gail has been an educator for 21 years. Before becoming a teacher, she worked in the medical field. A unique quality for Gail is that she has only worked at one school her entire educational career. She started in a first-grade classroom teaching all content. Later she became a Reading Recovery teacher for first-grade students and then an Early Intervention Program reading teacher. She became an assistant principal of instruction and for the last 3 years has served as the school principal.

Olivia

Olivia has 21 years in education. She has served as a teacher, assistant principal of instruction, and then a principal for 5 years. As a teacher she was grade-level chair and served on the Multi-Tier System of Supports Committee as a principal. She was assistant principal of instruction at the middle school level before becoming principal at an elementary school. While serving in leadership her school has been awarded a Military Flagship, and she proudly boasts it is the best school in town.

Liza

Liza has been at the elementary level her entire career. In 1993, she became a third-grade teacher, in 1994, she was a prekindergarten teacher, and from 1996 through 2004 she taught fifth grade. She served for 10 years as assistant principal of instruction and then moved to the principal position. She received the Teacher of the Year award in 1999 at her school and was also a county Teacher of the Year finalist. She is the facilitator of her principal mentor group.

Vanessa

Vanessa started her career as a Family Consumer Science teacher at a high school for 1 year, taught third grade 7 years, and taught fourth grade 1 year before becoming an assistant principal of instruction. She served at this level for 14 years and has been principal at the same school for 4 years. As a teacher, she served as a grade-level chair and the school leadership team member and chair. She also received the Teacher of the Year award and was among the county finalists. She serves on the county elementary handbook review committee and was on the Southern Association of Colleges and Schools committee. She shared that she loves her school and family and is a grandmother to the most precious granddaughter.

Kathy

Kathy started her educational career at the middle school level where she taught English language arts and social studies and was a reading connection teacher. As a teacher she was on the school's leadership team and the media committee. She serves on the Human Resource/Professional Learning Task Force and the county Multi-Tier System of Supports Committee.

Findings

This study was guided by three research questions:

1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?
2. What are the themes among principals concerning brain-based learning?
3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?

The rationale for using these questions was to determine the perceptions and implementation of brain-based learning in principals' schools. The data were used to determine the impact principals had on implementing brain-based learning within their school. The themes and theories were developed based on the structure, meaning, and the essence of the consciousness and experience from the point of view of the 12 participants. The audit method and triangulation, as described by Lincoln and Guba (1985), were used to ensure dependability, reliability, and consistency from the documentation of anecdotal notes, e-mails, verbatim transcriptions from the focus group and individual interview sessions, audio recordings, and field notes (Merriam & Tisdell, 2016).

Categories emerged as the researcher reviewed the narrative text from the interviews. These common categories recurred throughout the verbatim transcripts the researcher reviewed after reading and rereading the text. The subcategories were noted using frequency tables to determine the number of times the perceptions were noted in the transcriptions. This iterative process helped to identify the patterns, categories, and main themes that materialized throughout the interview responses (Taylor-Powell & Renner, 2003). As the researcher organized the data, these categories surfaced throughout the narrative documents. The perceptions were grouped into main categories identifying the main themes. These themes helped the researcher establish the relationships between each question asked during both interview sessions. Based on the data from the main themes, the researcher was able to interpret and answer each guiding research question.

Five techniques were used throughout the research data analysis: pattern matching, explanation building, time-series analyzation, logic models, and cross-case synthesis (Yin, 2018). The purpose of using these techniques was to generate high-quality results and findings. These interpretations of the results were based on the data analysis of the narrative text, recordings, and transcriptions. Select key points were thematic throughout each interview question. These common points were significant to the data analysis and enabled categories, subthemes, and major themes to appear to make connections, indicate relative importance, and develop contextual meaning. This insight allowed the researcher to note the differences and similarities in the perceptions of the 12 participants. The conceptual framework for this study informed the researcher through this system of constant comparison and examination of the beliefs, theories, assumptions, and expectations of the principals (Maxwell, 2009). Table 7 displays the major themes based on the guiding research questions.

Table 7

Themes Related to Guiding Research Questions

Research question	Major theme
1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?	Theme 1: Practices employed with brain-based learning
2. What are the themes among principals concerning brain-based learning?	Theme 2: Purpose and theories employed with brain-based learning
3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?	Theme 3: Role and influence of principals employed with brain-based learning

As the researcher sought to gain the insight of the principals during the interview to determine the impact of principal perception of brain-based learning, three themes and nine subthemes emerged. The credentialed interviewer asked 11 questions during the focus group session (see Appendix E) and nine questions during the individual interviews (see Appendix G).

Through intensive hand-written coding, the data were analyzed. The researcher began assembling the data by identifying common categories in the interview narrative. When organizing the responses to each question during the two interview questions, a structure began to take form similar to putting together a puzzle. Each narrative was a unit of information within the data analysis process. By connecting the frequency of the text, initial categories were formed, and patterns began to emerge (LeCompte, 2000).

Research Question 1 and Theme 1: Practices Employed With Brain-Based Learning

What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction? Categories that emerged from the data are shown in Table 8.

Table 8

Categories and Subthemes Related to Research Question 1 and Theme 1: Practices Employed With Brain-Based Learning

Categories	Subtheme	Theme
1. Engagement 2. Not a lecture environment 3. Active participation 4. Choice and variety	Environment	Practices employed with brain-based learning
5. Scientific research 6. How the brain works 7. Growing and building dendrites 8. Different learning styles	Neuroscience	
9. Leader in the building 10. Encourage the teachers 11. Support 12. Authority and responsibility to help	Leadership	
13. Teachers can learn best from each other 14. Believe in taking care of the teachers 15. Place an emphasis on brain-based learning	Perceptions	
16. It is about the children 17. Differentiated instruction 18. Movement 19. Set goals	Student learning	
20. Show us they can do it in multiple ways 21. Active with their learning 22. Brain-based strategy 23. Opposed to just regurgitation of facts	Instruction	
24. Bridge gaps 25. Interact with the curriculum 26. Not just old standardized way of testing	Curriculum	
27. Getting to know the child 28. Responsive teaching 29. Teacher more of a facilitator 30. Be flexible	Teaching	
31. Exposed to different types of brain-based research 32. Reflect in their progress 33. Love going to professional development	Professional learning	

Using a range of informants in the county helped the researcher triangulate the data and collect individual experiences and viewpoints. A rich understanding of the principals' beliefs, attitudes, and knowledge (Shenton, 2004) helped to construct Theme 1 and determine the importance of practices employed with brain-based learning. Common categories of subthemes concerning practices employed with brain-based learning among the principals are shown in Table 8.

Focus Group Interview Data

Responses to focus group Questions 1, 2, 3, 6, 9, 10, and 11 included references to brain-based practices used in the principals' school buildings. The questions were the following (also see Appendix E):

Q1: What is your definition of brain-based learning?

Q2: What is the role of brain-based learning activities in the curriculum at your school?

Q3: Give me some examples of brain-based learning activities at your school.

Q6: How can practitioners apply scientific knowledge related to recent research findings in neuroscience in the classroom?

Q9: How do brain-based learning activities influence student performance?

Q10: What is the role of teachers in implementing student achievement through brain-based learning activities and strategies?

Q11: Is there anything else you would like to add regarding brain-based learning and education?

Focus group responses yielded the following categories of data:

- student learning,

- finding best way students learn,
- link one thing to another,
- getting to know the child,
- keep them engaged,
- science and math and technology,
- interact with the curriculum,
- different parts of the brain,
- children coming up with own thoughts,
- repetition,
- children share and show their knowledge,
- differentiation,
- games that build the brain,
- grouping and collaboration among the students,
- time to process all the new information, and
- find the needs of the kids.

These categories contributed to the subthemes shown in Tables 8 and 9. Table 9 displays the number of times during the focus group references were made to the nine subthemes.

The major theme related to these questions was the practices employed with brain-based learning. The overarching subtheme related to these questions was practices connected to neuroscience. Willis (2018) defined brain-based learning as "student learning that is based on structural practices done to enhance student learning based on scientific research about how the brain works" (p. 2). Elton (2018) shared, "Any type of learning that is focused on growing, growing the dendrites in their brain, as opposed to, say, like worksheets or something like that to activate different connective tissue that link one thing to another" (p. 2). The neuroscience subtheme related to theme of practices included the phrases "scientific research," "finding the best way students learn," "getting to know the child," "more engaged," "motivate to learn," "meet needs of children," and "build dendrites."

Table 9

Frequency of Focus Group References to Subthemes Related to Research Question 1 and Theme 1

	Focus group question						
Subtheme	Q1	Q3	Q6	Q9	Q10	Q11	Total
Environment	1	7	8	5	2	1	24
Neuroscience	12	12	6	4	1	7	42
Leadership	0	0	0	3	0	0	3
Perception	2	0	9	12	5	4	32
Student learning	2	0	3	1	3	0	9
Instruction	2	10	0	5	0	0	17
Curriculum	2	2	1	1	0	0	6
Teacher	2	0	2	2	3	0	9
Professional learning	1	0	1	2	0	0	4

Note. $N = 12$.

The environment was deemed significant in almost every question asked related to the first guiding research question. The participants revered the environment as highly significant when discussing their school. Environment was discussed in every aligned question when considering brain-based learning and how it impacts instruction. Anna (2018) shared that the environment was one where children are to be "active with their learning, and they are moving around" (p. 14). Vanessa (2018) replied,

> Prekindergarten uses a lot of music and movement, and it helps to keep them engaged. And then in our upper grades, we do a lot of science and math and

> technology activities. And the students are able to learn at their own pace. . . . They picked up things that they enjoy most. And you really see a difference in how they enjoy coming to school and learning, but especially how they interact with the curriculum. (p. 6)

Lily (2018) shared the importance of breaks because of neuroscience research and the importance of “giving our children that release time and it is important to play” (p. 16). Charlotte (2018) added children learn differently and “can’t sit and get” (p. 16).

When asked about how brain-based learning influences student performance, the principals who responded all agreed these influences affect student performance. All nine subthemes were mentioned, especially their perceptions of how brain-based learning significantly relates to student performance. Crystal and Kathy both mentioned project-based learning and inquiry as it relates to neuroscience. Crystal (2018) stated, “I think the engagement piece is critical. Kids need to actually work with hands-on items” (p. 17). Vanessa (2018) responded,

> If children enjoy the learning, then it’s going to reflect in their progress and how they perform in school. Just like anything else, if you are enjoying it, then you want to do more . . . be the best you can be . . . because you enjoy what you are doing. And kids, I think kids enjoy school more than, say, when we went to school because they are not sitting in straight rows. They are sitting, you know, in different areas throughout the classroom, and they get to work with their friends. . . . I just think they really enjoy coming to school now, and it makes them do better. (p. 21)

Liza (2018) followed:

> Children of today are really forcing our teachers to use brain-based learning more, just so that they can survive. I mean, the children of today, they are all about hands-on, technology, and electronic. It's a fast-paced world. Their brains are all over the place. And to keep up with the children of today's perspective, teachers are having to have more professional development and change their way of thinking to incorporate a lot of everything. (p. 23)

At the end of the focus group, frustration with politicians and assessments emerged. Charlotte (2018) noted,

> We know how to connect with children and how to create an environment we are engaged in is so important, but it would be great if children were assessed the way that we know they learn, and we become so accountable for something that's so different. Because things have changed so much. . . . It would be nice if it all . . . aligned. (p. 27)

Anna (2018) followed by sharing,

> If I have a single target to worry about instead of every year let's change this, let's change that. You know, we really can't ever get a handle on what is expected from us. That is why we have to fall back on, we have to just do what's right for kids, and that is what it is all about. As long as we go to bed every night knowing that we have done the best we need to do for kids every day. (p. 27)

Individual Interview Data

Another source of data collected was the individual interviews. These four interviews allowed the researcher to gain additional experiences and viewpoints. The first guiding research question asked, "What are the principals' perceptions of brain-based learning, and how does this impact instruction?" Common categories emerged concerning practices employed with brain-based learning among the principals interviewed:

- differentiation,
- understanding the children,
- not a lecture kind of environment,
- active participation,
- teachers observe students through active engagement,
- integrate (content),
- give students the opportunity to expand what we have shown them,
- a synthesis process,
- hard to show with data because of accountability measures,
- make it make sense to the kid's brain,
- develop a classroom and instructional program that is sensitive to the biology of kids learning,
- hands on,
- learn from your peers' activities,
- students have a variety of emotional and physical needs,
- support teachers,
- operational procedures are child centered, and
- not one size fits all.

Responses to interview Questions 1, 3, 5, 6, 8, and 9 included references again about brain-based practices and the importance of the environment in their school building (also see Appendix G).

Q1: How would you describe brain-based learning at your school?

Q3: Can you give me some examples of how this has or has not influenced student learning?

Q5: Can you tell me more about the professional learning you are receiving?

Q6: How would you describe your role with the implementation of brain-based learning in your school?

Q8: In your opinion, does brain-based learning affect student achievement?

Q9: Is there anything else you would like to add regarding brain-based learning and education?

Table 10 displays the frequency data of subthemes from the individual interview sessions. As the researcher sought to delve deeper into the questions and glean more insight, the data analysis portrayed many more notations of the various subthemes. Environment and neuroscience were almost equally noted, and curriculum was not viewed as highly significant based on the subtheme frequencies. In addition, principals shared many more perceptions during the individual interview sessions and student learning was mentioned more frequently.

Table 10

Frequency of Interview References to Subthemes Related to Research Question 1 and Theme 1

	Interview question						
Subtheme	Q1	Q3	Q5	Q6	Q8	Q9	Total
Environment	25	16	6	14	0	2	63
Neuroscience	10	18	8	4	12	10	62
Leadership	0	0	8	17	0	2	27
Perception	2	12	6	10	16	0	46
Student learning	9	18	4	1	4	4	40
Instruction	5	13	2	2	2	2	26
Curriculum	0	5	0	0	0	1	6
Teacher	6	4	3	0	0	2	15
Professional learning	0	0	9	1	0	3	13

Note. *N* = 4.

When describing brain-based learning at their individual schools, the individual conversations continued in the same manner as the focus group, with an emphasis on not just the neuroscientific component, but the environment as well. Lilly (2018) began by sharing, “We are hands on and using those manipulatives learning through play. Students are engaged. . . . [A teacher] turns into that coach in the room. Teachers use brain-based movement activity” (p. 1). Anna (2018) shared, “We have a big focus on differentiated instruction and getting to know the students as individuals. Tailor things to optimize the student’s learning depending on what type of modality as they are learning” (p. 1).

Elton (2019) shared the importance of the environment:

> We put a very, very high threshold of our expectation on student engagement. We expect them to be an active participant in the learning, and in most part of our day it’s not a lecture kind of environment. It is not where kids see it and take notes and they never do anything. Now the kids do take notes for a few minutes

> and then I'm going to have an active part. I am going to have active participation. (p. 1)

Elton went on to describe how the teacher observed the students and students created artifacts that show they are solving math problems. The teachers had conversations with the students about their thinking, and overall the teacher noticed "how well they are taking on the learning. It is now kind of that cycle over and over" (Elton, 2018, p. 1). Willis (2018) shared the importance of curriculum and instruction by noting the importance of the components in the daily instructional activities: "More physical interaction with the learning manipulatives to dance to a song to movement around" (p. 1).

When asked about the effects of brain-based learning in their schools, the interviewed principals offered mutual agreement that this approach was beneficial. Ann and Lilly both shared examples of flexible seating in their schools. Lily (2018) explained, "They may be sitting in a wobbly chair while they are listening" (p. 1). Anna (2018) stated,

> A teacher just redid her room with the physical seating of her room. She had some wobble chairs and some cushions and things. She has lowered the tables, so the tables are at different heights. She is making sure she taps into not everyone sitting in that same desk, facing the same direction. She's got them in groups to collaborate and work with one another. There's a lot of choice and variety in our classrooms. (p. 1)

Anna went on to explain that these influences have an effect on student learning and motivate them to learn.

Professional development for the principal and teachers was mentioned much less often in the individual interviews, compared to six of the nine subthemes. Even though the frequency was lower, the comments attributed the practices in the school and strategies learned in the trainings as an important piece of the instructional practices at their schools that supported brain-based learning. The principals gave examples of how the professional learning at their schools directly aligned with the brain-based approach. Lilly (2018) shared her love of professional learning and described the importance of this training for not only her teachers, but also her professional growth:

> My teachers are constantly sending me those podcast or different articles about things they are interested in. Over the summer we did two different book studies and going into the school year we have what we call Lab Days. This year we have been really focused on small group instruction with cycle work and making sure our teachers are doing the diagnostic part so we can come together. We can figure out what the children’s actual needs are. (p. 3)

Anna shared her role in the professional learning community among principals in her county. Anna (2018) stated, “I am in a mentor group where we have two different books that we have been reading this year. We meet every few months” (p. 4). Anna (2018) described herself as a “self-motivator” and stated she is “just always trying to look for the best way to help our teachers work smarter and efficiently and meet the needs of our kids. I am always on several blogs and have memberships and organizations that send me stuff” (p. 4). She described the professional learning at her school as ongoing. Anna (2018) shared that her role in the professional learning process was one of support:

> Support is the biggest thing. I feel like support comes in many different ways. It could be through providing professional learning and guidance. Sometimes it's support in giving them the freedom to make mistakes and take risks. Sometimes it is financial support. Sometimes it is emotional support. I buy into the idea of service leadership. I really do think that I am here to serve the community and the students and parents. I believe in taking care of the teachers. They will take care of the kid and the parents. (p. 2)

The four principals unanimously agreed brain-based learning affected student achievement. Willis (2018) shared,

> We must understand that teaching and learning is a biological process and involves children [and] brains. Various children have different cognitive needs with vastly different cognitive experiences. We have to see we cannot approach our teaching and learning from a mechanical standpoint that if we teach it, they will learn it. We will see that there are a variety of factors involved. If we do not consider those factors, then we will not have the academic achievement we would have otherwise. (p. 2)

Anna (2018) noted, "Those teachers who are willing to do differentiated instruction and know it is not one size fits all. They are really willing to do what they need to meet the needs of their kids" (p. 5). Elton (2018) stated, "It is all about the thoughts, which is very brain based. It's not fill in the blank" (p. 5).

Research Question 2 and Theme 2: Purpose and Theories Employed With Brain-Based Learning

What are the themes among principals concerning brain-based learning? Research Question 2 was developed to gain understanding of the overall themes among principals concerning brain-based learning. By examining responses to each of the focus group session questions (Appendix E) and the individual interview questions (Appendix G), the purpose and various theories were discovered based on the perception of the participants. These themes concerning brain-based learning among principals were constructed and organized through the perceptions shared. Common categories of subthemes concerning Theme 2, purpose and theories employed with brain-based learning among the principals, are displayed in Table 11.

Focus Group Data

Each question in the focus group was examined for text with thick descriptions and compared to the relative studies reviewed in Chapter II in order to develop themes. Table 12 displays the number of times references were made in the focus group to the subthemes related to Research Question 2 and Theme 2.

Table 11

Categories and Subthemes Related to Research Question 2 and Theme 2: Purpose and Theories Employed With Brain-Based Learning

Categories	Subtheme	Theme
1. Actively involved 2. Not passively learning 3. Music and movement 4. Hands on	Environment	Purpose and theories employed with brain-based learning
5. Worksheets do not activate the brain 6. Higher order thinking skills 7. Synthesis and application of knowledge 8. Brain has to have time to catch up	Neuroscience	
9. Monitoring 10. Our role is support 11. Allow them to take their own initiative 12. Allow them to be professionals	Leadership	
13. Opposed to worksheets 14. Not everything has a singular right answer 15. Ok for it not to work	Perceptions	
16. Moving each one at their individual pace 17. Work it out among themselves 18. Give them the opportunity to expand what we have shown them 19. Book choices	Student learning	
20. Very clear teaching point 21. Pull into a small group 22. Content not in isolation 23. Manipulatives and learning materials	Instruction	
24. Integrated into the real things 25. Build an assessment that measures what we wanted children to be able to do 26. Learning continuums	Curriculum	
27. Try new things 28. Teacher no longer the person who holds all the knowledge 29. Teacher’s role facilitates and helps children understand 30. Collaborate	Teaching	
31. Not really calling it brain-based professional learning 32. Create professional learning 33. Teachers are having to have more professional learning	Professional learning	

Table 12

Frequency of Focus Group References to Subthemes Related to Research Question 2 and Theme 2

Subtheme	Focus group question Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total
Environment	1	7	7	7	13	8	0	6	5	2	1	56
Neuroscience	12	17	12	10	17	6	3	1	4	1	7	90
Leadership	0	0	0	12	1	0	0	8	3	0	0	24
Perception	2	1	0	18	7	9	1	1	12	5	4	50
Student learning	2	2	0	0	9	3	1	2	1	3	0	23
Instruction	2	14	10	1	8	0	8	1	5	0	0	49
Curriculum	2	1	2	0	2	1	2	0	1	0	0	11
Teacher	2	8	0	0	6	2	0	1	2	3	0	24
Professional learning	1	0	0	0	0	1	2	2	2	0	0	8

Note. $N = 12$.

The second major theme related to the 11 focus group questions was the purpose and theories employed with brain-based learning. All nine subthemes were mentioned throughout the focus group, but the responses about purposes and themes heavily referenced environment, neuroscience, leadership, student learning, and instruction. When examining the large amount of data, the researcher tried to be unbiased when developing the theme of purpose and theories of brain-based learning. As the researcher read the text numerous times, formative and tacit theories (LeCompte, 2000) were considered so that all data, not just the relevant data for the emerging themes, were considered and analyzed. Focus group categories concerning purpose and theories employed with brain-based learning among the principals were determined:

- Teachers and leaders need to get to know the child.
- Use the parts of the brain that make students able to retain, understand, and connect the learning.
- Differentiated instruction meets the needs of the kids.
- Students learn a variety of ways.
- Use strategies to meet the student's needs.
- Give opportunities for students to show how and what they are learning.
- Students must be actively engaged.
- The more different ways we engage the brain, the more children are going to learn it.
- Make decisions to use strategies to increase student engagement.
- Include synthesis and application of knowledge.
- Use a recursive cycle.
- Environment is not quiet.
- Students work together and share their thinking, lead each other to higher levels.
- Leader sets the tone, culture, and expectations.
- Leader creates the professional learning.
- Leader is the support for the building.
- Teacher is the facilitator and helps children understand.

Saldaña (2009) explained, "A theme is a phrase or sentence describing more subtle and tacit processes" (p. 13). These key assertions are generalizations related to purpose and theory and were collected simultaneously through the data analysis process.

By identifying these important sets of statements, the researcher was able to determine the perceptions through descriptive concepts concerning brain-based learning. This process also allowed the researcher to closely triangulate the data, making the validity stronger (Saldaña, 2009).

Anna (2018) articulated,

> Getting to know the child, that responsive teaching and then the instruction, or differentiated instruction is really the way I think of it a lot of times. Your differentiation of the instruction meets the needs of the kids. In that case, meaning how you deliver the material, the visuals that you use, the activities that you use, to really help that student make that connection. So it comes in a variety of ways. You may use some music, you may use organizers, you may create an environment that's more conducive to learning, flexible seating or by the lighting in the room. I think it just takes on lots of different aspects, and every teacher kind of has their own little set of toolkits of what they like to use and prefer to try and meet the needs of those students. (pp. 3-4)

Anna's synopsis of activities in her school includes several of the themes noticed among principals. Her perception specifically includes the environment, neuroscience, teacher, student learning, curriculum, and instruction. She stressed five major ideas: various student learning styles, strategies to meet the needs of students, methods to engage the brain different ways, differentiation of instruction and curriculum, and the importance of the environment. Researchers Uzezi and Jonah (2017) also found that achievement on tests improved if students were motivated and had a good attitude. Although Anna did not specifically mention student achievement, her description of the methods and knowledge of the teacher implies that student needs are being met in her school, which would likely improve the attitude of students.

Gail (2019) commented further on the importance of the teacher's role, the recursive cycle, and including synthesis and application of student knowledge:

> I think also in addition to what we offer as staff, it's allowing children to take in and then push out the application of what they are learning and them taking it to another level. Challenging them so that they let you know how they work and learn. And we, as educators, we have an opportunity to sort of see how they best learn and use those strategies so that we meet their needs and will allow them the opportunity to show how they are learning. (p. 5)

The focus group transcriptions highlighted repeatedly the importance of the leader. Some of the major themes included how the leader is responsible for the tone, culture, expectations, professional learning, decision-making process, and overall support of school staff. Willis (2018) elaborated,

> The principal should organize the school in a way that has kids' real needs in mind. We can create a master schedule, and we can organize the school thinking about what's going to work best for, I hope the operation. But we think about when we schedule our recesses and how we schedule our lunches and how much we allow teachers and make it easy for teachers to build breaks in and then how we support things that happen inside the classroom with very limited resources. So I think creating an environment and financially supporting an environment that is sensitive to real learning needs of children. (p. 10)

Another theme concerning leadership with the culture and expectations was developed when focus group Question 7 was asked about the professional learning of teachers. The overall response was that the school and county professional development was embedded but did not use the term *brain-based learning*. Shirley (2018) explained,

> I don't think we say we are doing brain-based professional learning. It is more, you know, best practices, small group instruction, differentiation, different strategies that will help meet the needs of the students, but . . . we are not really calling it brain-based professional learning. (p. 18)

Kathy (2018) commented, "I would say it is embedded. Our teachers . . . what they are doing is based on research, and it is based on brain-based research" (p. 19). Olivia (2018) agreed: "And to add, a lot of it can be connected with allowing teachers to use their data to drive instruction . . . based on student needs. Being specific to the content or specific curriculum" (p. 20)

Neuroscience was referenced 90 times, more than any other subtheme. This concept was documented repeatedly in the verbatim notes of the recordings and quickly became an emergent category and then theme. These connections were discussed by Anna (2018): "Those connections help to bridge the gaps and build those dendrites and everything that they're learning and have them more engaged and motivated to learn" (p. 3). Elton (2018) added, "It's all about active engagement. The students aren't passively learning; they are actively involved in what they are doing" (p. 4). Julie (2018) continued, "Being active with their learning, and they are moving around and having fun as we, you know, push them and continue working, you know, right at that zone of proximal development" (p. 4).

Other phrases included comments such as, “Let them show us many different ways.” Anna (2018) emphasized the importance of neuroscience when she stated, “Show us they can do it in multiple ways, engage the brain, and learning in several different ways” (p. 6). Liza (2018) shared a similar sentiment when she stated, “Hands-on activity that has their brains stimulated and engaged. Inquiry-type activities where they are having to use those brains and think through problems and situations and have to come up with solutions” (p. 6). These direct quotes demonstrate how principals valued neuroscience as a requirement for the success of student learning.

Individual Data Analysis

The individual interview responses yielded the following common categories for Theme 1, purpose and theories employed with brain-based learning:

- many components to effectively reach children;
- incorporate variety of ways in daily instruction;
- modalities of thinking;
- active engagement;
- cycle over and over;
- differentiated instruction;
- physical engagement;
- teacher making connections to the previous learning;
- a lot of choice and variety in the classroom;
- worksheets do not activate anything in the brain;
- motivate children;
- heavy in the professional learning communities;

- identify children's needs;
- constantly go to workshops and conferences and read professional literature; and
- establish routines, environment, schedule, and operational procedures that are child centered.

Table 13 displays the number of times references were made in individual interviews to the subthemes for degree of purpose and theories employed with brain-based learning. The individual interview sessions varied some with more frequency and emphasis with the overall professional learning process and student learning. Because the researcher was able to compare the focus group to the individual interview sessions, connections were made based on not just frequency but also the verbatim statements of the participants.

Table 13

Frequency of Interview References to Subthemes Related to Research Question 2 and Theme 2

	Interview question									
Subtheme	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
Environment	25	20	16	3	6	14	5	0	2	91
Neuroscience	10	12	18	6	8	4	1	12	10	81
Leadership	0	0	0	3	8	17	8	0	2	38
Perception	2	2	12	13	6	10	10	16	0	71
Student learning	9	8	18	1	4	1	1	4	4	50
Instruction	5	15	13	10	2	2	1	2	2	52
Curriculum	0	4	5	12	0	0	0	0	1	22
Teacher	6	9	4	1	3	0	0	0	2	25
Professional learning	0	0	0	9	9	1	3	0	3	25

Note. $N = 4$.

Spradley (1980) described the researcher’s need to observe and review data with introspection. When reviewing conversations, text and verbal recordings, objectivity was needed to understand the meaning and be explicitly aware while experiencing the role of an outsider and insider simultaneously. The recordings and text served as a means to compile the data to realize and understand the themes through passive participation (Spradley, 1980).

In reviewing the perceptions of the principals using a deeper lens through the individual interview sessions, the data analysis revealed many of the same purposes and theories employed with brain-based learning. The individual interview questions were an extension of the focus group questions. The purpose of the session was to allow the researcher to extend the thinking of the selected participants, expand on the identified categories developed from the focus group (Taylor & Renner, 2003), and validate the data (Saldaña, 2009).

The themes overall were exactly the same in theory and purpose but semantically varied. Comparing the responses in the focus group and individual sessions, the frequency the environment was noted at least doubled with almost every question in the individual interviews. Willis (2018) expressed the importance of the school schedule: “Mornings are different than afternoons. Learning times prior to lunch differ than learning times after lunch” (p. 1). Lilly (2018) described her school environment as one where “students are engaged with brain-based movement activities” (p. 1). Elton (2018) shared specifics of a classroom observation where students had been taught facts about slavery and then were asked by the teacher to form opinions based on those facts and write an essay: “Give them information that is the facts but ask them in writing to determine what were the fallacies in the thinking about race. Give me three things that would show that was not right" (p. 2). In addition, Anna (2018) mentioned the importance of brain-based learning on student achievement: "Teachers that are willing to do the differentiated instruction and really drill down on looking at what kids need and use small group instruction" (p. 6).

Student learning was another subtheme mentioned numerous times throughout the individual interviews that supported the participants' perception of the purpose and theory employed with brain-based learning. Anna (2018) shared the importance of student growth and implementing brain-based learning to accelerate their growth: "A big influence and overarching influence is that [teachers] are willing to take the risk and do things to really improve their own professionalism but also their classrooms for kids" (p. 6). Willis (2018) shared his belief that schools should develop "a classroom instructional program that is sensitive to the biology of kids learning" (p. 2).

In addition, Elton (2018) noted the importance of the teacher with student learning: "What I saw today . . . the teacher began the lesson, and it began with the teacher making a connection to the previous learning. . . . She connected with it. . . . She gave a very clear teaching point" (p. 1). Lilly (2018) stated, "You look at those small little steps with children" (p. 2). She offered an example: "We are helping the children to transition that phonics into their reading and into their writing. So it's more natural. So it makes sense to the kid's brain. Our children are being able to transfer it" (Lilly, 2018, p. 2).

Research Question 3 and Theme 3: Role and Influence of Principals Employed With Brain-Based Learning

What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools? The third theme established from the data sources was the importance of the school leadership, specifically the role and influence of principals employed with brain-based learning. This theme was established based on the conceptual framework from the research: practice, perceptions, and theories. This triangulation ensured trustworthiness in the researcher's data analysis and allowed the researcher to dig deeper in the text. Despite the importance of leadership in schools, throughout the literature review, little research was found concerning leadership perspectives with teaching and learning. Through the studies on brain-based learning, this perspective was vital for understanding the emphasis and influences of the principal and the principal's role for school improvement achievements (Iachini et al., 2015). New understandings of how the brain functioned were increasingly linked to student achievement (Schachter, 2012); therefore, principals' perspectives were key to understand and determine how brain-based learning impeded and promoted staff instruction and student learning (Iachini et al., 2015). Table 14 presents the subthemes and categories related to Research Question 3 and Theme 3.

Table 14

Categories and Subthemes Related to Research Question 3 and Theme 3: Role and Influence of Principals Employed With Brain-Based Learning

Categories	Subtheme	Theme
1. Having fun 2. Principal should organize the school 3. Make it easy for teachers to build breaks in 4. Grouping and collaboration among the students	Environment	Role and influence of principals employed with brain-based learning
5. Learning is biological, not mechanical 6. Will not learn if they don't feel loved 7. Help student make a connection 8. How you think about it	Neuroscience	
9. Get them what they need 10. Give them permission to fail 11. Support things that happen in the classroom 12. Set the tone, culture, expectations	Leadership	
13. All students can succeed 14. Encouragement so important 15. Just do what is right for kids	Perceptions	
16. Engagement inventories 17. Motivation 18. Getting students to own it a little bit more 19. Problem solving	Student learning	
20. Academic opportunities 21. Ways to differentiate our instruction 22. Data to drive instruction 23. Target instruction	Instruction	
24. Common formative assessments 25. Putting the content areas together 26. Variety	Curriculum	
27. Modeling 28. Teacher goes around room 29. Conferring with various students d 30. Tap into the differences	Teaching	
31. Heavily engaged in the professional learning process 32. Different book studies 33. Doing a better job looking at the data	Professional learning	

Focus Group Data

Emerging themes were determined concerning the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools. Common focus group categories developed for the role and influence of principals employed with brain-based learning:

- instruction,
- create an environment,
- support as much as they need,
- actively involved,
- allow teachers to be professionals,
- memory has a part in everything we do,
- classrooms are not quiet,
- not really calling it brain-based professional learning,
- organize the school thinking about the best strategies,
- financially support an environment,
- differentiation,
- teachers as creators, and
- leader in the building.

Focus group Questions 2, 4, 5, 7, 8, and 11 allowed the researcher to determine the perceptions of the principals and the emphasis on brain-based learning in their schools(see Appendix E):

Q2: What is the role of brain-based learning activities in the curriculum at your school?

Q4: What is the role of the principal in regard to brain-based learning activities in the school?

Q5: What brain-based strategies are used in classrooms at your school?

Q7: What professional learning are teachers receiving concerning brain-based learning?

Q8: In what ways do you think your role in brain-based learning impacts the performance of your students?

Q11: Is there anything else you would like to add regarding brain-based learning and education?

Table 15 displays the number of times references were made in the focus group to the degree of role and influence of principals employed with brain-based learning.

Table 15

Frequency of Focus Group References to Subthemes Related to Research Question 3 and Theme 3

	Focus group question						
Subtheme	Q2	Q4	Q5	Q7	Q8	Q11	Total
Environment	7	7	13	0	6	1	34
Neuroscience	17	10	17	3	1	7	55
Leadership	0	12	1	3	8	0	24
Perception	1	8	7	1	1	4	22
Student learning	2	0	9	1	2	0	14
Instruction	14	1	8	8	1	0	32
Curriculum	1	0	2	2	0	0	5
Teacher	8	0	6	0	1	0	15
Professional learning	0	0	0	2	2	0	4

Note. *N* = 12.

Similar findings with Theme 3, the role and influence of principals employed with brain-based learning, were found throughout the data. When analyzing the frequency of the nine subthemes, neuroscience was once again the most cited concept. In addition, environment was noted second, and instruction was emphasized more.

Vanessa (2018) started the conversation when asked about the role of the principal. She commented that her role was one of support:

> Supporting them [teachers] along the journey and allowing them to be professional and try things to see if it works for their kids. What works for them in their instruction. We try to support as much as they need because we all want our kids to be the best they can be. (p. 9)

Lily (2018) followed by sharing, “One of my jobs is to help our teachers be risk-takers, just like our children” (p. 9). The importance of the teacher was frequently cited, 24 times, during the focus group session. Lily (2018) referenced the importance of the teacher taking risks:

> Because every child is different, and they don’t learn the same way and so getting in there and finding out what works may not be what you’ve done before. You’ve got to get in there and find it and so take a risk so you can get that child where they need to be. (p. 9)

Crystal continued the conversation with brain-based learning in the classroom. The principal’s role is to take “initiative too . . . providing STEM activities, the supplies that they [teachers] may need. . . . We have to allow time as well. . . . Games that build the brain” (Crystal, 2018, p. 11)

Instruction, mentioned 34 times, was also deemed important by the principals. Kathy (2018) gave an example: “Scaffolding information and having students analyze it and revise it again. Kind of keeping that as a recursive cycle for the kids” (p. 13). Lily (2018) mentioned classrooms where “students are working together, sharing their thinking, and leading each other to higher levels. Putting the content areas together . . . combine those kind of subjects together” (p. 13) Anna and Elton (2018) included the importance of “brain breaks” and “down time.” “Your brain has to have time to catch up, but also it has to have time to kind of process that new information and think about how to use it” (Anna, 2018, p. 14). Vanessa (2018) continued by noting, “That’s the way they do their instruction. They have the mini-lesson that’s 10 to 15 minutes of that direct instruction, and then they get to go off and apply that learning” (p. 15).

Individual Interview Data

Digging deeper into the participants’ perceptions through the individual interview sessions allowed the researcher to ascertain and triangulate the data. Common interview categories concerned the relationship between the principals’ perceptions and their emphasis on brain-based learning:

- needs of kids of today;
- professional learning;
- determine children’s needs;
- indirectly many of our professional learning opportunities touch on aspects of brain-based learning;
- the authority and ability;
- support;

- establish routines, environment, and schedule;
- show a belief;
- do what is asked of teachers;
- they keep learning because I keep pushing;
- big influence;
- encourage; and
- evolved.

By examining the text from individual interview Questions 2, 4, 6, 7, and 9 (see Appendix G), the researcher was able to continue the examination of references concerning the perceptions of the principals and the emphasis in their building regarding brain-based learning. The following interview questions were relevant:

Q2: Could you please describe to me what I would see in a classroom in your school that was implementing brain-based learning?

Q4: Can you tell me more about the professional learning your teachers are receiving?

Q6: How would you describe your role with the implementation of brain-based learning in your school?

Q7: In what ways does your influence as a principal have on brain-based learning at your school?

Q9: Is there anything else you would like to add regarding brain-based learning and education?

Table 16 displays the frequency data for the degree of role and influence of principals employed with brain-based learning in the individual interview sessions.

Table 16

Frequency of Interview References to Subthemes Related to Research Question 3 and Theme 3

	Interview question					
Subtheme	Q2	Q4	Q6	Q7	Q9	Total
Environment	20	3	14	5	2	44
Neuroscience	12	6	4	1	10	33
Leadership	0	3	17	8	2	30
Perception	2	13	10	10	0	35
Student learning	8	1	1	1	4	15
Instruction	15	10	2	1	2	30
Curriculum	4	12	0	0	1	17
Teacher	9	1	0	0	2	12
Professional learning	0	9	1	3	3	16

Note. $N = 4$.

For Theme 3, degree of role and influence of principals employed with brain-based learning, the top five subthemes mentioned from greatest to least were environment, perceptions, neuroscience, leadership, and instruction. The frequency of these subthemes ranged from 44 times to 30 times (see Table 16). Compared to the focus group, frequency decreased for curriculum, professional learning, student learning, and teacher. These ranges dropped considerably and ranged from 17 times to 12 times (see Tables 15 and 16).

Based on the focus group and compared to the individual interview session, much of the rhetoric continued to be the same in content when answering interview Questions 2, 3, 6, 7, and 9. The descriptions, examples, and perceptions of the role and influence of the principals were consistent with a high emphasis with the same subthemes. Lilly (2018) postulated her perceptions of these subthemes, specifically describing the classrooms in her school, through statements such as, “Make sure there is a visual . . .

kinesthetic, visual, and auditory" (p. 1). Elton (2018) shared the importance of the instruction: "Model strategies to figure out the difficult words. Then give the children their own difficult word. It is not just tell the partner what the word was but use the strategy to solve the word" (p. 1). Willis (2018) further described a classroom: "You see students doing a lot more physical interaction with the learning manipulatives, dance to a song to move around. . . . They are more physically engaged" (p. 1).

Leadership continued to be high importance. Anna (2018) illustrated this by sharing an example of her conversation with a teacher from her school:

> I think what I see from my teachers that has been an influence on them because they will come to me and say, "Can I try this? I would like to try this." Or, "Have you read this article?" Or, "I think this might be something we could use." (p. 5)

Willis (2018) also shared this sentiment of the importance of leadership: "I am also allocating the resources that we allow for children, for children's learning in a way that is sensitive to the biology of a child's learning needs" (p. 2). Lilly (2018) responded that teachers "want to keep learning because I keep pushing. I have, I think, sometimes, far more influence than I want" (p. 4). Elton (2018) illustrated his leadership importance by sharing,

> When the teachers are struggling with something, it is my job to come in there and try to help them think through it. Not to give it to them, because that would put myself in a situation where I would be saying I know the answers. (p. 3)

Data Analysis

The recordings of the focus group and individual interview sessions, the transcriptions, and the hand coding all allowed the researcher to triangulate and develop themes for this study. The data from the focus group and individual interview sessions allowed the researcher to develop three themes. Theme 1 was practices employed with brain-based learning. Theme 2 was purpose and theories employed with brain-based learning. Theme 3 was role and influence of principals employed with brain-based learning. The findings were continuously compared and reviewed in relation to the three guiding research questions. The purpose of this study was to determine the association between the principals' perceptions of brain-based learning and the instruction at their schools. The research design included a qualitative case study to determine principals' perceptions and themes of mind, brain, and education science. The knowledge of these common elements was useful in determining the patterns found between various principals and the impact the leaders had based on the perspective of neuroscience as it relates to education.

Organization of Data Analysis

The themes were the result of many handwritten codes, and review of the verbatim recordings for common patterns. The researcher repeated this review of the recordings and notes numerous times to ensure responses and frequency were properly recorded and analyzed. The themes were developed after the determined subthemes were created from the continual review using the constant comparative approach: environment, neuroscience, leadership, perceptions, student learning, instruction, curriculum, teaching, and professional learning.

Interpretation of Results

The first developed theme was practices employed with brain-based learning, which originated from the many illustrations given by the principals. Each principal had concrete perceptions of the practices that should be included with brain-based learning. These practices included a heavy emphasis on instruction, environment, and neuroscience. Repeatedly, neuroscience and environment were postulated as the top two most important subthemes. The principals were specific in how they defined and described brain-based learning and the practices implemented at each of their schools. This theme included practices, such as an active environment where students were engaged. Rather than lecturing students and having them complete worksheets, teachers engaged students based on individual student needs. In addition, the principals viewed structural practices as a vital piece of managing a school. These practices were viewed as needing to be scientific in nature and centered on the students at all times and in all operations of the school. Instructionally, the premise was to grow students through hands-on activities, choice and variety in the classroom, and a need for professional learning to grow teachers and leaders.

The second theme of purpose and theories employed with brain-based learning was the foundational core or framework when discussing brain-based learning. These key elements were established based on the principals' perceptions and the data collected from every question in both interview and focus group sessions. The theory behind the perceptions of brain-based learning in schools included various modalities of thinking, a variety of strategies used in the daily instruction within the classrooms, differentiated instruction, and the importance of professional learning to help assist leaders and teachers figure out the academic needs and solutions for students. Further, principals included the need for establishing routines, schedules, an environment, and operational procedures that were child centered. These key concepts were stated throughout the focus group and individual interviews, with the results showing high levels of feedback centered around neuroscience and instruction. Environment was recognized, along with student learning and leadership, as crucial for the implementation of brain-based learning. These purposes and theories were the base for the stated beliefs and perceptions of the participants.

The third theme posited the perceived role and influences of principals employed with brain-based learning. These roles and influences commenced from the descriptions and perceived influences school principals have on brain-based implementation at the school level. These results included a higher emphasis on neuroscience and the environment in both interviews and focus groups and included the premise of individual student needs. These needs required teachers and leaders to take some risks to meet student needs with instruction and with the essential resources. The emphasis on neuroscience centered on the need for sensitivity to the biology of the child's learning needs and helping teachers. Principals viewed leadership as support on many levels of the school. Resources, time, finances, and professional learning communities were part of this support platform in the schools.

Summary

The purpose of Chapter IV was to provide a narration of the findings of the impact of principals' perceptions of brain-based learning. After reviewing all the data, a triangulation process was used to determine the emergent themes related to brain-based learning that have directly affected the research-based methods and processes that practitioners use daily. The researcher interpreted these themes and determined how perspectives, especially principal perceptions of brain-based learning, affected student achievement. The discoveries were shared through direct text, frequency tables, and subtheme tables with categories and themes pursuant to a constant comparative approach through the data analysis process. The researcher ascertained multiple perspectives and identified the factors pertinent to instruction and brain-based learning. These findings were communicated through three themes constructed around the three guiding questions for the research study. From the analysis of data, the findings are informative to administrators and other stakeholders charged with achieving high levels of student learning and performance. By determining the relationship, knowledge, and perceptions of various elementary principals, information was shared to improve student instruction and pedagogy.

CHAPTER V

DISCUSSION

To endure the changes of society, advanced research regarding the brain, Common Core standards, and advances in technology, the focus for educators has shifted through the years (Hohnen & Murphy, 2016). The information in Chapter I introduced those changes and introduced mind, brain, and education science. This newer field was the merger of neuroscience and education. Both the classroom and the lab disseminated information that was relevant and practical for educators to make this shift and embrace the new challenges. The new approach from mind, brain, and education science offers a new dimension, and the relationship between these three fields encourages a new perspective. Students need to synthesize information and be able to solve problems that traditional, previous pedagogical practices alone cannot teach (Tokuhama-Espinosa, 2011).

Principals, specifically, need to be knowledgeable of evidence-based strategies and practices (Lynch, 2016) because of their influence on a school. Through this research, gaps were found in the literature concerning the association between the principal's perceptions of brain-based learning and instruction. This gap was postulated in Chapter I and highlighted the background of the problem, the research questions used to guide the research, and significance of the study. The purpose of this study was to determine the association between the principals' perceptions of brain-based learning and the instruction at their schools. The goal of the investigation was to determine the knowledge and perceptions of various elementary principals regarding brain-based learning to improve pedagogy and student instruction. The results portrayed themes among principals, relationships between the principals' perceptions, and the perceptions' impact on instruction in each school.

Chapter II outlined the review of the literature, including the transdisciplinary study of brain function and the learning process as the foundation for the research. The review began by providing the historical background from the early records, the 1800s, the 1900s, and the current multidisciplinary connections. Literature provided information on the physiology of neuroscience, including the brain, learning structure, environment, brain plasticity and malleability, memory, emotions, mindset, and motivation and learning. Improvements in neuroimaging have contributed to understanding uses of brain-based learning in the classroom. Traditional lecture was compared to brain-based learning, and the transdisciplinary gap was described. Chapter II continued to outline the literature related to curriculum and instruction, professional learning needs for educators, and the influence and perspective of leaders. The gap in the literature concerning leadership perspectives of brain-based learning served as the framework and basis for the study.

The researcher presented the methodology for the study in Chapter III. The methodology included the research questions, research design, and the research setting and participants. The qualitative study included the constant comparative approach using a constructivist perspective. By collecting data through a focus group and individual interviews, this case study was used to determine emergent themes among principals related to brain-based learning. The data analysis process allowed the researcher to interpret principals' perspectives of brain-based learning and determine the common knowledge through the interview dialogue. Chapter III also included the negotiation of access, the researcher's role, methodological assumptions, trustworthiness, ethical considerations, and procedures.

Chapter IV presented the findings of the data analysis, which was done through hand coding. The three research questions were the elemental basis for the entire chapter. The findings included three themes based on frequency tables and participant quotations. Research Question 1, "What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction?" yielded Theme 1: practices employed with brain-based learning. Research Question 2, "What are the themes among principals concerning brain-based learning?" established Theme 2: purpose and theories employed with brain-based learning. Research Question 3, "What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?" yielded Theme 3: role and influence of principals employed with brain-based learning. These three themes were the major findings identified as pertinent to the principals' perspectives concerning their impact of brain-based learning.

Analysis and Discussion of Research Findings

Multiple data sources were used and triangulated to obtain the research findings. Anecdotal notes and verbal descriptions were transcribed verbatim using focus group interviews and additional individual interviews. The researcher sought to engage principals, gain an understanding, interpret, and determine the meaning by synthesizing and analyzing the interview data (Merriam & Tisdell, 2016). The goals of the case study were to use qualitative methods and research methods to answer the three research questions using a constructive view and a constant comparison approach (Creswell, 2014; Gay & Airasian, 2003; Merriam & Tisdell, 2016). The three themes presented represent the beliefs and assumptions of the participants that formed their perceptions of brain-based learning.

Research Question 1

What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction? Principals discussed their interpretations and the related impact on instruction using brain-based learning. Perceptions were articulated when the principals shared the different practices used within their school and discussed different examples regarding the influence on student learning. Theme 1 emerged: practices employed with brain-based learning. These beliefs defined principals' perceptions of brain-based learning, including brain-based learning in the curriculum and instruction, impact on student performance, activities used within the school, the role of teachers, and strategies to apply brain-based learning within the classroom. The overall view was that the practices used in their school were founded in neuroscience practices. In addition, principals noted the environment had direct effects on learning.

Research Question 2

What are the themes among principals concerning brain-based learning? Based on the discussion among the interview sessions, themes involving brain-based learning were created, and purposes were shared. These perceptions offered insight into the case study by sharing the beliefs of the principals concerning the importance of brain-based learning in their school. Theme 2 emerged: purpose and theories employed with brain-based learning. Participants indicated the theory and purpose of implementing a brain-based learning approach within their building. These purposes and theories from the participants were included in every question asked during the focus group and individual interviews. The importance of using neuroscientific findings was heavily noted along with the environment and instruction.

Research Question 3

What is the relationship between the principals' perception and their emphasis on brain-based learning in their schools? In answering Research Question 3, participants shared their perceptions and emphasis of brain-based learning in their schools. Relationships between this perception and the emphasis of brain-based learning were developed based on the roles of the principals and the implementation of brain-based learning activities on their campuses, along with the strategies, professional learning, and the impact on student performance. Theme 3 emerged: role and influence of principals employed with brain-based learning. Combining the focus group and individual interview sessions, neuroscience practices continued to be mentioned frequently, followed by environment and instruction. Specifically, in the individual interviews, more emphasis was placed on leadership. Principals noted roles, descriptions, and the influence of the principal along with a description of classrooms. The use of brain-based learning in the curriculum led to discussion of instruction used in the classroom and the impact of student performance.

Discussion of Research Findings

Multiple sources were reviewed through the triangulation process. This hand-coding and review process resulted in nine subthemes and three major themes. Through the literature review, the researcher was able to analyze numerous studies and several major studies. However, little was found concerning the implications of leadership perceptions of brain-based learning within the educational system. Patron and Waxman (2016) posited the importance of leadership having critical knowledge to assist and guide teachers, which ultimately benefits the students within the school.

The guiding research questions were the framework used to verify the implications and elaborate the perceptions of principals. The findings resulted in the contrast and comparison with the literature based on the data collection and analysis. The researcher gained knowledge through combining the current literature with the meanings, behaviors, causes, and experiences (Bogdan & Biklen, 2007) of the participants to answer the three research questions.

Research Question 1. What are the principals' perceptions of brain-based learning, and how do these perceptions impact instruction? It was important to ensure principals had a good and accurate understanding of brain-based learning to better understand roles, classroom and school implementation of this approach, implication for student learning, and the needed professional development. Vyas and Vashishtha (2013) found when brain-based principles were included in instruction, the learner was the focus. Pera (2014a, 2014b) noted memory occurred through a process with select neural structures; experiential learning causes the integration of these neural networks (Schenck & Cruickshank, 2015). This memory, along with attention, is fundamental to learning (Tokuhama-Espinosa, 2011). Working memory requires more than rote repetition (Zadina, 2015). Brain-based learning includes valuable research from neuroscientists and includes various brain scanning techniques and other studies to offer educators new practices (Ferrari, 2011).

Brain-based principles include the foundational importance of the environment to have interdependency in the classroom (Conner & Sliwka, 2014). Teachers are expected to have the necessary knowledge for teaching and learning, but studies have indicated that the leadership of the principal directly affects how strategies, curriculum, and overall instruction are implemented (Brown, 2016). Principals with the appropriate critical knowledge are able to guide and assist teachers (Padron & Waxman, 2016). The rationale for the qualitative study following the theoretical framework of constructivism came from the idea that principals are expected to lead and increase engagement, commitment, and capacity for goal attainment of the organizations they lead. Specifically, for this research, categories and themes that built a relationship in regard to brain-based learning were determined based on the collection of data from the case study (Balyer, 2012).

The participants in the study were able to define brain-based learning and had similar views, experiences, and expectations concerning the implementation of brain-based learning in their schools. Both the focus group and individual interview sessions produced subthemes and major themes that related to the practices employed with brain-based learning. Neuroscience and environment were mentioned most frequently in both interview sessions. The participants all agreed brain-based learning had significant influences on student performance. The environmental expectations of the principals were aligned with the brain-based principles found in the literature study. In every interview session, principals mentioned active students using hands-on practices in the classroom, along with the importance of differentiated instruction to meet the learners' individual learning needs. Duman (2010) stated instructional approaches should be diverse and include various instructional methods. Many of the major studies found brain-based learning to be much better for student learning and achievement (Balim, 2013; Duman, 2010; Gulpinar et al., 2015; Gozuyesil & Dikici, 2014; Kwek, 2011; Uzezi & Jonah, 2017; Vyas & Vashishtha, 2013).

Practices. Theme 1 was created based on the subthemes from the participants' responses and were parallel with the literature. The practices discussed included inquiry-based instructional strategies and the use of technology. Educators approached teaching and learning with a biological perspective of the brain and understanding the various cognitive needs of the students. Students need an understanding of how to think and problem solve, whereas educators understand and include these practices to maximize learning (Gozuyesil & Dikici, 2014). Environment is also a major component of brain-based learning. Principals frequently noted and discussed this subtheme.

Research Question 2. What are the themes among principals concerning brain-based learning? The participants' frequent statements included and reiterated the importance of neuroscience, environment, their perceptions, student learning, and instruction with brain-based learning. Both sets of questions (focus group and individual interview) included components of and were aligned with the major theme of purpose and theories employed with brain-based learning. One purpose of brain-based learning is the student's ability not only to learn the material but also to be able to synthesize and apply the knowledge to future learning. Leadership was also deemed an important factor to many of the components that influence brain-based learning in a school.

Several relevant studies in Chapter II posited the importance of leadership influence and perspectives. Shen et al. (2012) studied 256 principals to measure the extent principals used data to help with decision making and connected leadership to student achievement. Leadership is second to teaching in factors that impact the learning level of students. In addition, principals affect achievement through their influence (Pierce, 2014) and perceptions of the academic climate of the school (Urick & Bowers, 2014). Research has suggested that implementing brain learning principles and interventions will boost student achievement and learning (Butler et al., 2014; Gulpinar et al., 2015), mirroring the connection with the principal's knowledge and perception of these concepts (Gurley et al., 2016). This leadership theme also included the expectations and culture set by the leader.

The importance of neuroscience continued to be a prominent theme during all interviews. Several participants specifically mentioned (a) connecting and building the dendrites in a student's brain and (b) keeping students active and engaged with the learning in the classroom. The principals in the individual interviews mentioned environment more than neuroscience practices, but text from both the focus group and individual sessions was aligned.

Student learning and the teacher were also revealed as important aspects of brain-based learning. Clement and Lovat (2012) explained teachers must understand the specific content but also understand how to teach the content. The earlier movement for the transdisciplinary knowledge of education and neuroscience seemed to be understood by the principals during the interviews. Vyas and Vashishtha (2013) recognized the role of how the brain processes, perceives, stores, and retrieves information during the learning process. Although none of the participants explicitly discussed brain-based learning as a neuroscientist, or included specific functions and processes for learning to take place in a child's brain, all were well versed in the overall purpose and theory behind brain-based learning.

Participants also noted teachers needed to be knowledgeable with brain-based learning because of societal changes. Tokuhama-Espinosa (2008) determined in her research that teachers should receive professional learning in neuroscience education to learn how students learn and how to teach students to learn. A study comparing lecturing to brain-based learning strategies indicated that if the teacher that did not ask students higher order questions, students lacked the metacognition to apply and synthesize the information (Balim, 2013). Hook and Farrah (2013) and Waree (2017) found that teachers with brain-based learning competency provided beneficial effects on student achievement. Participants echoed professional learning as important and described examples of classroom instruction using brain-based strategies. Several participants shared the specific term *brain-based learning* might not be used in their conversations with faculty or in trainings, but they felt the concept was embedded throughout their practices and procedures.

Purpose and theories. Theme 2, purpose and theories employed with brain-based learning, was created after the researcher hand coded the focus group and individual interviews through the data analysis process. Several factors emerged from this review of the categorical units of data into subthemes. The interview session responses supported the importance of the teacher meeting the needs of the students, which was prevalent throughout both the focus group and the individual interview sessions. Participants felt students learn through a variety of ways, which requires not only the teachers, but also the leaders to know their students and how they learn. Hruska et al. (2016) determined memory structures varied in activation based on the prior knowledge of the participants. Brain-based learning allows students to stay actively engaged while also learning at their individualized level of knowledge. Balim's (2013) research supported the need for brain-based strategies, such as mind mapping, to increase student learning and achievement. The participants also had a theory that decisions determined by the teacher and leadership of a school affected the outcome of the student's ability to apply the learning. The purpose of a school was to engage the brain. This theory was portrayed by participants sharing an example of students working together and communicating their thoughts in order to lead one another in their thinking. In addition, Kwek (2011) found teachers need to understand the value of the instructional strategies and approaches used daily their classroom.

Research Question 3. What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools? Research Question 3 specifically highlighted the relationship of the principals and the evidence of brain-based learning in their buildings. As principals reflected, the relationship and perception of brain-based learning showed parallel patterns and fundamental variables among the group. Neuroscience and environment continued to be a common subtheme, but principals offered more dialogue about instruction and leadership. They offered distinct thoughts about the role the principal has at a school as well as the understanding of the influence that a principal has on every aspect of the campus. Principals repeatedly mentioned that students learn best through a variety of methods and have varying needs.

Vyas and Vashishtha (2013) posited the classroom was the setting for the learning organ, the brain. Balim (2013) studied two groups in a science classroom to determine if inquiry-based learning, along with mind-mapping strategies, affected student achievement. Achievement and retention scores on posttests increased significantly. Although assessment scores were not addressed in this study, the principals' perceptions were aligned with this same thinking through the use of brain-based learning on various campuses. Several examples of linking previous learning to new learning were shared in the conversations during the interviews, and specific examples were given about taking new learning and applying it students' existing knowledge.

The goal of the researcher was to take bits of knowledge and synthesize all the information together. An example was shared when a participant explained a recent observation in a classroom. The goal for the teacher was the student's ability to take the new learning and create a writing artifact using opinion. The student assignment was to give specific examples or ideas based on an inquiry-based question as a prompt. The principal felt this prompt was a strong example of brain-based learning because several steps were involved, which required the learner to take former knowledge, apply to the new knowledge, and produce an opinion based on the facts.

Role and influence. Every participant expounded on the importance of merging content and applying new knowledge with previous knowledge. Vygotsky and Piaget were pioneers with this mindset of allowing fundamental learning to continue to develop into adulthood (Liu & Chiang, 2013). Participants described various brain-based learning principles similar to the seven principles determined by Conner and Sliwka (2014) as guiding and foundational assumptions. The participants also heavily noted the need for critical thinking and not just relying on rote memorization (Greenwald & Quitadamo, 2014).

Professional learning was also part of their role and influence employed with brain-based learning. Clement and Lovat (2012) urged educators to not only understand content but also know how to teach the content. This understanding requires training for not only the teachers, but also the leaders of the school (Ansari et al., 2011). Shaughnessy (2016) determined educational leaders placed great emphasis on equipping teachers with strategies so students ultimately graduated. Several researchers (Dekker et al., 2012; Ferrari, 2011; Pasquinelli, 2012) found that teachers believed misconceptions, or neuromyths. False assertions with brain research were often marketed by developers of commercial products. Only one participant mentioned the difference in brain-based learning today from years before. Specific examples about lighting, scents, and classical music were mentioned, followed by the changes based on using the brain-based principles.

Lynch (2016) cited instructional knowledge of the principal as a critical responsibility to provide effective instruction. Leaders provide information to teachers and stay focused on approaches to improve student learning and achievement (Shen et al., 2012). Leaders, and educators in general, are required, through accountability, to assimilate instructional frameworks within the standards and emphasize real-world networks and problem solving (Ross & Cozzens, 2016). Principals committed to this process require the inquiry-driven and brain-based pedagogy using Common Core standards (Ratzer, 2014). This pivotal role requires school leaders and teachers to build these skills into the standards, determine teaching strategies that should be used to master the standards, and focus on structural teaching and learning approaches. Kwek (2011) maintained that principals' perceptions directly shape learning and curricular decisions.

The various roles and influences of principals employed with brain-based learning were reflected not only in the literature but also in the interview sessions. Disdain was common when the topic of assessment was mentioned. Principals agreed that brain-based learning principles improved student knowledge and achievement, but the assessments required by legislature did not assess the learning using the same method. The high-stakes testing involved and the heavy emphasis on school improvement caused frustration. Allen et al. (2015) included the reform process in their research and shared leadership factors that had been deemed successful. One of the leadership styles noted was transformational leadership. Brown (2016) reiterated some of these effective leadership traits and included the importance of collaboration and communication. Expanded issues such as learning supports, mental health, and overall youth development were directly affected by the leaders' perceptions regarding the priorities of these areas (Iachini et al., 2015). Participating principals identified the tone, culture, support, school operations, finances, expectations and other school-related items as important factors for school success. The principals' perceptions aligned with the literature, placing a high attribution to the impact principals have regarding brain-based learning.

Conclusions

The purpose of this study was to determine the association between the principals' perceptions of brain-based learning and the instruction at their schools. Examination of the literature, the research data, and the guiding questions allowed perceptions to be evaluated and patterns and practices within a variety of schools to be determined. The findings offered the educational field insight on the impact principals' perceptions have on brain-based learning to improve student learning and teaching practices. Using the constructivist perspective and a constant comparison approach, the researcher interpreted these themes and determined how principal perceptions of brain-based learning affect student achievement and overall the education of students (Gay & Airasian, 2003).

Three research questions guided this qualitative research study. The first question, “What are the principals’ perceptions of brain-based learning, and how do these perceptions this impact instruction?” addressed how the principals defined brain-based learning, how it was used in their schools, the applicability of brain-based learning research, the role of teachers, and the influences on student achievement. The findings lead to the conclusion that principals have an overall accurate understanding of brain-based learning and its positive effects on student achievement. The principals understood the practices involved and heavily relied on neuroscience, the environment, and their own perceptions to employ these influences throughout their campus. Active engagement, a connection to the students, and love for learning were part of creating a positive environment. Participants agreed the impact of brain-based learning was favorable, especially with the rigor of current job offerings. Several expressed the need for brain-based learning in schools just to survive the fast pace of technological changes. These findings were aligned with the literature reviewed. A sense of urgency and importance was found in several studies (Conner & Sliwka, 2014; Ferrari, 2011; Hohnen & Murphy, 2016; Kwek, 2011; Perry, 2014; Vyas & Vashishtha, 2013), especially when considering the ongoing changes in society and with technology.

The second research question, “What are the themes among principals concerning brain-based learning?” addressed the meaning, behavior, experiences, and causes of the perceptions expressed. Every question discussed in the interviews allowed the researcher to look for common knowledge among the perceptions of the group to determine any emergent themes. By understanding the conversations, feelings, thoughts, beliefs, and values of the participants through the individual and focus group interviews, the researcher was able to analyze data through a bounded system. Nine subthemes were intertwined throughout the entire case study: environment, neuroscience, leadership, perception, student learning, instruction, curriculum, teacher, and professional learning. These themes helped the researcher define the purpose and theories employed. The importance of the neuroscience research, environment, and instruction was continually noted in all interview sessions. The researcher concluded the principals' perceptions varied minimally, which allowed the researcher to review the participant expressions and strengthen the validity of the findings. Differentiation was a common and all-encompassing theme in all the questions. Differentiated instruction (Conner & Sliwka, 2017; Duman, 2010; Tokuhama-Espinosa, 2011) was found in the literature as well to be an element of brain-based learning.

The third research question, "What is the relationship between the principals' perceptions and their emphasis on brain-based learning in their schools?" addressed influences, roles, professional learning, and descriptions of the participants. The last guiding question narrowed the focus, and roles and influences of principals employed with brain-based learning were determined. These conclusions continued with the same alignment of the importance of neuroscience, environment, and instruction as the most common themes. The role of the principal was valued highly, and principals overwhelmingly indicated that teachers needed leadership support. The expectations for instruction were also clear. Principals stated repeatedly the importance of teachers meeting the child at the individual level of learning and scaffolding learning in a recursive manner to engage the brain for the child to retain new information.

Additionally, the influence the leader has on the school was considered extremely important. Individuals mentioned the high level of responsibility and understood their role in promoting teacher and student learning. Some principals were reluctant to embrace the high level of influence they have in their own schools. Support was an ongoing theme throughout every interview and was described as an important part of principal's job to help teachers accomplish the established school goals and requirements.

Relationship to Research

This study investigated the perception of principals regarding brain-based learning and the impact on the use of brain-based learning in school instruction. The researcher used a qualitative method in a bounded case study to build themes using a constructivist doctrine (Bamkin et al., 2016). The data were collected from a focus group and individual interviews. Based on these data, the researcher was able to interpret and construct the principals' views using the three guiding research questions (Bamkin et al., 2016; Mack et al., 2005). Three major themes and nine subthemes were determined based on textual descriptions of the interview sessions. These descriptions were hand coded, and a pattern of meaning using a constant comparative approach was used to investigate the point of view based on principal perception (Creswell, 2014).

Conceptual Framework

The conceptual framework was based on the practice, perceptions, and theories of the principal perceptions. The data from this research study indicated these three concepts overlap and work independently to collectively form the three major themes:

practices employed with brain-based learning, purpose and theories employed with brain-based learning, and the role and influence of principals employed with brain-based learning. By understanding the perceptions and views of each principal, collectively and individually, common knowledge was established and analyzed.

The data analysis process allowed the researcher to conclude the perception of the importance of brain-based learning varied little based on the interview sessions. The conceptual framework modeling the practice, perceptions, and theories as the baseline for this study was determined to be accurate. This insight also paralleled the literature review. Each principal appeared to understand and embrace the need for brain-based learning in both theory and practice. The researcher concluded the principals placed significant value on the premise behind the neuroscientific evidence of brain-based learning, the learning environment, and their knowledge of brain-based learning. These three concepts dominated the principals' responses in the interview sessions.

By using qualitative research, the researcher was able to gain insights about the principals. These insights included the importance and power a person's perception has in decision-making. Each principal spoke positively about brain-based learning. The only negatives articulated concerned state testing. Principals expressed great concern regarding the difference between teaching methods used to help students through brain-based practices and how the state tests children. Although a need for alignment between the school's instructional beliefs, instructional practices, and testing was mentioned, a genuine concern for doing what is right for the children was pervasive. The researcher concluded the perceptions were the guiding force in everything the principals believed, valued, and shared.

The perspective of principals' perceptions of brain-based learning was minimal in the literature review. Through this review and study, the researcher concluded that the perception of the individual principal was the predominant factor in the influence the leader has on the building for instruction, operations, and the culture of a school. Although the concepts around neuroscience and environment were more frequently noted, the researcher concluded the principals were the driving forces for this thinking. The resulting framework differed from the initially expected framework, presented as Figure 1 in Chapter I, in that the intersection of perceptions increased; see Figure 2.

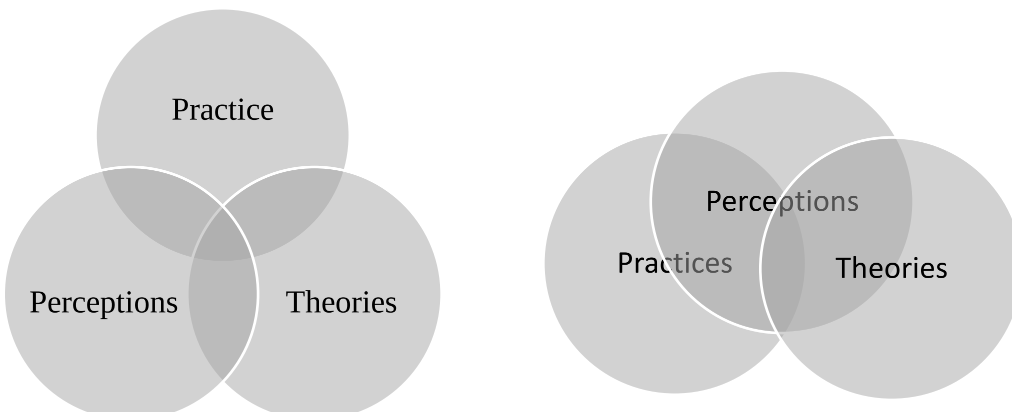

Figure 2. Conceptual framework before (left) and after (right) analysis of study data.

Implications

The principals valued brain-based learning and understood the significant effects it has on student achievement and the overall development of the child. The testimonies and literature reviewed also demonstrated the foundational need for the teacher and leader to understand each child to continue in the learning process. As society and jobs have transformed, so have methods of pedagogy. This value of specific pedagogical methods transforms into a deeper understanding of the different concepts taught in school, where the leader drives and develops instruction. In addition, the leader should understand the basic physiology of the brain to assist the teachers in the pursuit of teaching new concepts that student brains will process, store, and retrieve (Handayani & Corebima, 2017). This cognitive process, as noted by the principals and in the literature (Balim, 2013; Schenck & Cruickshank, 2015), is necessary to develop the student beyond the rote memorization of concepts and into a higher level of learning.

Based on these findings, the implications from this study have greatly impacted each participant’s school and will be shared with the school system and with other principals in the county. The literature and the perceptions of the principals suggested the association between the perception of a school leader and effective implementation of brain-based learning. This case study featured a variety of schools, and the outcomes were the same at each school. Brain-based learning principles and activities were perceived by the building principal as successful and directly affected learning outcomes.

Recommendations

The following recommendations pertain to principals, administrators, and teachers at all levels as a means to strengthen the practice of brain-based learning for all students at all levels.

1. Brain-based learning in the literature and in the view of the principals was deemed important, and thus more professional development is needed to increase the level of understanding of the physiology of the brain and the practical application of this knowledge through brain-based learning.
2. Given the overwhelming views and alignment to brain-based principles, the study should be replicated in other counties with differing demographics. It also should be replicated in other states with groups of educators.

3. Although participants seemed to understand brain-based learning, no participant mentioned neuromyths or neuroplasticity, and only surface physiological knowledge of the brain was specified. Another way to deepen this study would be to survey a leader's knowledge of the brain and how it relates to brain-based learning. Such a study could determine the next steps needed in professional learning for teachers regarding how the brain works and how to instruct students with varying content. By increasing this knowledge, student achievement would be assumed to increase.
4. A quantitative study could be done by adding surveys. By using surveys, breadth would be added to the research and would give additional and more specific information on the knowledge of principals at the elementary, middle, and high school levels concerning the physiology of the brain and other brain-related information.
5. This study was conducted to determine the impact of the principals' perceptions of brain-based learning. The research for this study could be extended to include how brain-based learning is connected to state standards and the state teacher evaluation (Georgia Teacher Keys Evaluation System). Additional research questions could be asked to determine how to extend the three themes and nine subthemes from the current study. Additionally, this same study could be researched again within 5 years to determine if any of the brain-based principles or principals' perceptions have changed.

Dissemination

The purpose of this study was to determine the principals' perceptions of brain-based learning. By using the guided research questions, examining the literature, and using the research design, the researcher was able to collect information and determine the impact a principal's perception has on brain-based learning. This perception guides the decisions made in the schools and affects the environment, instruction, curriculum, professional learning, student learning, and the teachers within each school. The researcher plans to share the findings in this study with the elementary principals within the county and will request to meet with the executive cabinet, which includes all county department heads. In addition, the researcher will meet at the county level with parent teacher organizations, county partners in the community, teachers throughout the county, and with various professors in the education departments at local colleges and universities. The published copy of the dissertation will also be available in the Columbus State University library. The researcher will seek ways to publish the results of the study in a peer-reviewed journal and share these findings in various conferences held around the state.

Concluding Thoughts

By better understanding the significance of brain-based learning, members of the educational system within Georgia and around the world can build better and more knowledgeable students prepared for the 21st century. The participants from this study provided information about how the perceptions of principals affect student learning and achievement. Principals must lead a school in a way that promotes student learning, be able to decipher best research practices, effectively run the operations of the school, and see to many other leadership responsibilities. These practices and understandings are directly determined by a principal's perception.

In this case study, the perception of brain-based learning was reviewed. The guiding questions allowed the researcher to determine the patterns, practices, beliefs, and experiences as told by the principal through interview sessions. Every principal interviewed had a good foundational knowledge of brain-based learning and the practices necessary to meet students' needs. These findings established the importance of theory and practice within each school for ongoing school improvement. The principals were keenly aware of the rigorous standards and the expectations required of not only their leadership, but also in the practices of their teachers and in student learning.

The rigor and the expectations set by the principal allowed the students to benefit from brain-based practices and principles that guided the school to improve instruction and the overall learning environment. The evidence from this study serves as a guide to principals to examine their practices and develop as school leaders. This information is also valuable for teachers and leaders in the educational field to reflect on individual practices and stay knowledgeable of research-based strategies that support brain-based learning. The results from this case study established that an individual's perceptions of brain-based learning directly determine and affect the practices and approach implemented at the school level. Researchers, administrators, and teachers need to continually learn from the literature and examine instructional practices to increase and improve student instruction and pedagogy. Educators must be informed about recent research and maintain a focus on the child as the learner. The researcher has learned the significant value in reflection and the need to examine practices, products, procedures, and the overall networking of a school. Through this examination and reflection, the researcher has realized the importance of prioritizing brain-based learning.

REFERENCES

Aldrich, R., (2014). Nature, nurture and neuroscience: Some future directions for historians of education. *Paedagogica Historia, 50*, 852-860. doi:10.1080 /00309230.2014.948011

Allen, N., Grigsby, B., & Peters, M. (2015). Does leadership matter? Examining the relationship among transformational leadership, school climate, and student achievement. *International Journal of Educational Leadership Preparation, 10*(2), 1-20.

Anderson, O. R., Love, B. C., & Tsai, M.-J. (2014). Neuroscience perspectives for science and mathematics learning in technology-enhanced learning environments. *International Journal of Science and Mathematics Education*, *12*, 467-474. doi:10 .1007/s10763-014-9540-2

Ansari, D., Coch, D., & Smedt, B. A. (2011). Connecting education and cognitive neuroscience: Where will the journey take us? *Educational Philosophy and Theory*, *43*(1), 37-42. doi:10.1111/j.1469-5812.2010.00705.x

Artino, A. R., Holmboe, E. S., & Durning, S. J. (2012). Can achievement emotions be used to better understand motivation, learning, and performance in medical education? *Medical Teacher*, *34*, 240–244. doi:10.3109/0142159X.2012.643265

Atabaki, A., Dietsch, S., & Sperling, J. (2015). How to separate learning myths from reality. *McKinsey Quarterly*, *3*(3), 1-4. Retrieved from http://www.mckinsey.com /business-functions/organization/our-insights/how-to-separate-learning-myths -from-reality

Azer, S., Guerrero, A., & Walsh, A. (2013). Enhancing learning approaches: Practical tips for students and teachers. *Medical Teacher*, *35*, 433-443. doi:10.3109/0142159X.2013.775413

Bakanay, C. D., & Cakir, M. (2016). Phenomenology and its reflections on science education research. *International Online Journal of Educational Sciences, 8,* 161-177. doi:10.15345/iojes.2016.04.014

Bakkum, B. (2015). NEUROwords: The line of Gennari—Sometimes history gets it right. *Journal of the History of the Neurosciences, 24*(1), 95-101. doi:10.1080/0964704X.935654

Balim, A. G. (2013). The effect of mind-mapping applications on upper primary students' success and inquiry-learning skills in science and environment education. *International Research in Geographical and Environmental Education, 22*, 337-352. doi:10.1080/10382046.2013.826543

Balyer, A. (2012). Transformational leadership behaviors of school principals: A qualitative research based on teachers' perceptions. *International Online Journal of Educational Sciences, 4,* 581-591. Retrieved from http://mts.iojes.net//userfiles/Article/IOJES_949.pdf

Bamkin, M., Maynard, S., & Goulding, A. (2016). Grounded theory and ethnography combined. *Journal of Documentation, 72,* 214-231. doi:10.1108/JD-01-2015-0007

Bogdan, R., & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods* (5th ed.). Boston, MA: Pearson.

Bouffard, S., & Savitz-Romer, M. (2012). Ready, willing, and able. *Educational Leadership, 69*(7), 40-43. Retrieved from http://www.ascd.org/publications /educational-leadership/apr12/vol69/num07/Ready,-Willing,-and-Able.aspx

Boyles, D. (2014). Brain matters: An argument for neuropragmatism and schooling. *Philosophy of Education Archive,* 403-411. Retrieved from https://educationjournal.web.illinois.edu/archive/index.php/pes/article/view /4036.pdf

Breen, S. (2014). Making sense of neuroscience research. *Kodaly Envoy, 41*(1), 4-9.

Brown, G., III. (2016). Leadership's influence: A case study of an elementary principal's indirect impact on student achievement. *Education, 137*(1), 101-115.

Butler, A. C., Marsh, E. J., Slavinsky, J. P., & Baraniuk, R. G. (2014). Integrating cognitive science and technology improves learning in a STEM classroom. *Educational Psychology Review, 26,* 331-340. doi:10.1007/s10648-014-9256-4

Caine, R. N., & Caine, G. (1994). *Making connections: Teaching and the human brain.* Menlo Park, CA: Addison-Wesley.

Cerasoli, C. P., Nicklin, J. M., & Ford, M. T. (2014). Intrinsic motivation and extrinsic incentives jointly predict performance: A 40 year meta-analysis. *Psychological Bulletin, 140,* 980-1008. doi:10.1037/a0035661

Chandler, L., & Baldwin, C. (2010). Views from the water's edge: The impact of images in communicating perspective of climate change. In M. Raesch (Ed.), *Mapping minds* (pp. 95-106). Oxford, England: Inter-disciplinary Press.

Clement, C., & Lovat, T. (2012). Neuroscience and education: Issues and challenges for curriculum. *Curriculum Inquiry, 42*, 534-557. doi:10.1111/j.1467-873X.2012.00602.x

Connell, J. D. (2009). The global aspects of brain-based learning. *Educational Horizons, 8*8(1), 28-39. Retrieved from https://www.jstor.org/stable/42923784

Conner, L., & Sliwka, A. (2014). Implications of research on effective learning environments for initial teacher education. *European Journal of Education, 49*(2), 165-177. doi:10.1111/ejed.12081

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Los Angeles, CA: Sage.

Degen, R. J. (2014). Brain-based learning: The neurological findings about the human brain that every teacher should know to be effective. *Amity Global Business Review, 9*(1), 15-23.

Dekker, S., Lee, N., Howard-Jones, P., & Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology, 3*(429), 1-8. doi:10.3389/fpsyg.2012.00429

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education.* New York, NY: Columbia University.

Dewhurst, S. A., Holmes, S. J., Brandt, K. R., & Dean, G. M. (2006). Measuring the speed of the conscious components of recognition memory: Remembering is faster than knowing. *Consciousness and Cognition, 15*, 147-162. doi:10.1016/j.concog.2005.05.002

Dosa, K., & Russ, R. (2016). Beyond correctness: Using qualitative methods to uncover nuances of student learning in undergraduate stem education. *Journal of College Science Teaching, 46*(2), 70-81. Retrieved from https://www.jstor.org/stable/24892451

Duman, B. (2010). The effects of brain-based learning on the academic achievement of students with different learning styles. *Educational Sciences: Theory and Practice, 10*, 2077-2103. Retrieved from ERIC database. (EJ919873)

Elwick, A. (Ed.). (2014). *An awareness of neuroscience in education: Can learning about the brain transform pupils' motivation to learn?* Reading, England: CfBT Education Trust. Retrieved from ERIC database. (ED546812)

Felder, R. M. (1996). Matters of style. *ASEE Prism, 6*(4), 18-23. Retrieved from https://www.jstor.org/stable/24155919

Ferrari, M. (2011). What can neuroscience bring to education? *Educational Philosophy and Theory, 43*(1), 31-36. doi:10.1111/j.1469-5812.2010.00704.x

Ferrari, M., & McBride, H. (2011). Mind, brain, and education: The birth of a new science. *Learning Landscapes, 5*(1), 85-100. doi:10.36510/learnland.v5i1.533

Fry, C. L. (Ed.). (2014). *Achieving systemic change: A sourcebook for advancing and funding undergraduate STEM education.* Washington, DC: Association of American Colleges and Universities. Retrieved from https://www.aacu.org/sites/default/files/files/publications/E-PKALSourcebook.pdf

Gay, L. R., & Airasian, P. (2003). *Educational research: Competencies for analysis and applications* (7th ed.). Upper Saddle River, NJ: Pearson.

Gaziel, H. (2003). Images of leadership and their effect upon school principals' performance. *International Review of Education, 49,* 475-486. doi:10.1023/A:1026353007490

Georgia Department of Education. (2017). *Science standards-based classroom instructional framework.* Retrieved from https://www.gadoe.org/

Glaser, B. E., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* New Brunswick, NJ: Transaction.

Gokce, B., Guney, S., & Katrinli, A. (2014). Does doctors' perception of hospital leadership style and organizational culture influence their organizational commitment? *Social Behavior and Personality, 42*, 1549-1562. doi:10.2224/sbp.2014.42.9.1549

Goleman, D. (2014). *What makes a leader: Why emotional intelligence matters.* Florence, MA: More Than Sound.

Governor's Office of Student Achievement. (2018). Home page. Retrieved from https://gosa.georgia.gov/

Gozuyesil, E., & Dikici, A. (2014). The effect of brain-based learning on academic achievement: A meta-analytical study. *Educational Sciences: Theory and Practice*, *14*, 642-648. Retrieved from ERIC database. (EJ1038792)

Greenwald, R., & Quitadamo, I. (2014). A mind of their own: Using inquiry based teaching to build critical thinking skills and intellectual engagement in an undergraduate neuroanatomy course. *Journal of Undergraduate Neuroscience Education, 12*(2), 100-106.

Gulpinar, M. A. (2005). The principles of brain-based learning and constructivist models in education. *Educational Sciences: Theory & Practice, 5*, 299-306. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3970991/

Gulpinar, M. A., Isoglu-Alkac, U., & Yegen, B. C. (2015). Integrated and contextual basic science instruction in preclinical education: Problem-based learning experience enriched with brain/mind learning principles. *Educational Sciences: Theory & Practice, 15*, 1215-1228. doi:10.12738/estp.2015.5.0095

Gurley, D., Anast-May, L., O'Neal, M., & Dozier, R. (2016). Principal instructional leadership behaviors: teachers vs. self-perceptions. *NCPEA International Journal of Educational Journal Leadership Preparation, 11*(1), 140-155. Retrieved from http://www.ncpeapublications.org/attachments/category/125/IJELP_Volume_11_Number_1_(Spring_2016).pdf

Hallinger, P., & Murphy, J. F. (1987). Assessing and developing instructional leadership. *Educational Leadership, 45*(1), 54-61.

Handayani, B. S., & Corebima, A.D. (2017). Model brain-based learning (BBL) and whole brain teaching (WBT) in learning. *International Journal of Science and Applied Science: Conference Series, 1*(2), 153-161. doi:10.20961/ijsascs.v1i2.5142

Harkness, S. S., & Stallworth, J. (2013). Photovoice: Understanding high school females' conceptions of mathematics and learning mathematics. *Educational Studies in Mathematics, 84*, 329-347. doi:10.1007/s10649-013-9485-3

Hebb, D. (1949). *The organization of behavior.* New York, NY: Wiley.

Heystek, J. (2015). Principals' perceptions of the motivation potential of performance agreements in underperforming schools. *South Africa Journal of Education, 35*(2), Article 986. doi:10.15700/saje.v35n2a986

Hinton, C., Fischer, K., & Glennon, C. (2012). *Mind, brain, and education.* Washington, DC: *Jobs for the Future.* Retrieved from https://www.jff.org/resources/mind-brain-and-education-student-center-series/

Hohnen, B., & Murphy, T. (2016). The optimum context for learning: Drawing on neuroscience to inform best practice in the classroom. *Educational & Child Psychology, 33*(1), 75-90.

Hook, C., & Farah, M. (2013). Neuroscience for educators: What were they seeking, and what were they finding? *Neuroethics, 6*, 331-341. doi:10.1007/s12152-012-9159-3

Hruby, G. (2011). Commentary: Minding the brain. *Journal of Adolescent and Adult Literacy, 54*, 316-321. doi:10.1598/JAAL.54.5.1

Hruby, G., & Goswami, U. (2011). Neuroscience and reading: A review for reading education researchers. *Reading Research Quarterly, 46*, 156-172. doi:10.1598/RRQ.46.2.4

Hruska, P., Krigolson, O., Coderre, S., McLaughlin, K., Cortese, F., Doig, C., . . . Hecker, K. (2016). Working memory, reasoning, and expertise in medicine—Insights into their relationship using functional neuroimaging. *Advances in Health Sciences Education, 21*, 935-952. doi:10.1007/s10459-015-9649-2

Hughes, D. L., & DuMont, K. (2002). Using focus groups to facilitate culturally anchored research. In T. A. Revenson, A. R. D'Augelli, S. E. French, D. L. Hughes, D. Livert, E. Seidman, . . . H. Yoshikawa (Eds.), *Ecological research to promote social change* (pp. 257-289). Boston, MA: Springer. doi:10.1007/978-1-4615-0565-5_11

Iachini, A. L., Pitner, R. O., Morgan, F., & Rhodes, K. (2015). Exploring the principal perspective: Implications for expanded school improvement and school mental health. *Children & Schools, 38*(1), 40-48. doi:10.1093/cs/cdv038

Johnson, R. B., & Christensen, L. (2017). *Educational research: Quantitative, qualitative, and mixed approaches* (6th ed.). Thousand Oaks, CA: Sage.

Kall, L B., Malmgren, H., Olsson, E., Linden, T., & Nilsson, M. (2015). Effects of a curricular physical activity intervention on children's school performance, wellness, and brain activity. *Journal of School Health, 85*, 704-713. doi:10.1111/josh.12303

Kapadia, R. H. (2013). Level of awareness about knowledge, belief and practice of brain-based learning of school teachers in greater Mumbai region. *Procedia–Social and Behavioral Sciences, 123*, 97-105. doi:10.1016/j.sbspro.2014.01.1402

King, R. B., & McInerney, D. M. (2016). Culturalizing motivation research in educational psychology. *British Journal of Educational Psychology, 86*, 1-7. doi:10.1111/bjep.12106

Kwek, S. H. D. (2011). *Innovation in the classroom: Design thinking for 21st century learning* (Master's thesis). Retrieved from https://web.stanford.edu/group/redlab/cgi-bin/materials/Kwek-Innovation%20In%20The%20Classroom.pdf

LeCompte, M. D. (2000). Analyzing qualitative data. *Theory Into Practice*, *39,* 146-154. doi:10.1207/s15430421tip3903_5

Lemberger, M. E., Brigman, G., Webb, L., & Moore, M. M. (2011). Student success skills: An evidence-based cognitive and social change theory for student achievement. *Journal of Education, 192,* 89-99. doi:10.1177/0022057412192002-311

Lincoln, Y. G., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Liu, C.-J., & Chiang, W.-W. (2013). Theory, method and practice of neuroscientific findings in science education. *International Journal of Science and Mathematics Education, 12,* 629-646. doi:10.1007/s10763-013-9482-0

Lynch, J. (2016). Effective instruction for students with disabilities: Perceptions of rural middle school principals. *Rural Special Education Quarterly, 35*(4), 18-28. doi:10.1177/875687051603500404

Mack, N., Woodsong, C., MacQueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative research methods: A data collector's field guide.* Research Triangle Park, NC: Family Health International.

Maxwell, J. (2009). Designing a qualitative study. In L. Bickman & D. J. Rog (Eds.), *The Sage handbook of applied social research methods* (2nd ed., pp. 214-253). Thousand Oaks, CA: Sage. doi:10.4135/9781483348858.n7

Masson, S., & Foisy, L.-M. B. (2014). Fundamental concepts bridging education and the brain. *McGill Journal of Education, 49*, 501-512. Retrieved from https://mje.mcgill.ca/article/view/9172/6990

Matuliauskaite, A., & Zemeckyte, L. (2011). Analysis of interdependencies between students' emotions, learning productivity, academic achievements and physiological parameters. *Science–Future of Lithuania, 3*(2), 51-56. doi:10.3846/mla.2011.032

McCall, L. (2012). Brain-based pedagogy in today's diverse classroom: A perfect fit—But be careful! *Delta Kappa Gamma Bulletin, 78*(3), 42-47.

Menary, R. (2014). Neural plasticity, neuronal recycling and niche construction. *Mind & Language*, *29*, 286-303. doi:10.1111/mila.12051

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). San Franciso, CA: Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Moustakas, C. (1990). *Heuristic research design, methodology, and applications.* Newbury Park, CA: Sage.

No Child Left Behind Act of 2001, Pub. L. No. 107-110 (2002).

Northouse, P. G. (2015). *Leadership theory and practice* (7th ed.). Thousand Oaks, CA: Sage.

Ortega, F. (2009). The cerebral subject and the challenge of neurodiversity. *BioSocieties, 4*, 425-445. doi:10.1017/S1745855209990287

Padron, Y., & Waxman, H. (2017). Investigating principals' knowledge and perceptions of second language programs for English language learners. *International Journal of Educational Leadership and Management, 4*(2), 127-146. doi:10.17583/ijelm.2016.1706

Pasquinelli, E. (2012). Neuromyths: Why do they exist and persist? *Mind, Brain, and Education, 6*, 89-96. doi:10.1111/j.1751-228X.2012.01141.x

Pera, A., (2014a). The integration of cognitive neuroscience in educational practice. *Contemporary Readings in Law and Social Justice, 6*(1), 70-75.

Pera, A., (2014b). Neural mechanisms underlying school-based learning. *Contemporary Readings in Law and Social Justice, 6*(1), 7-12.

Pierce, S. (2014). Examining the relationship between collective teacher efficacy and the emotional intelligence of elementary school principals. *Journal of School Leadership, 24*, 311-335. doi:10.1177/105268461402400204

QSR International. (2018). NVivo v. 12.1 (Computer software). Retrieved from https://www.qsrinternational.com/nvivo/nvivo-products

Quin, Y. (2012). Active learning: Is it just a fad? *Innovation, 11*(1), 51-53.

Ratzer, M. B. (2014). Opportunity knocks: Inquiry, the new national social studies and science standards and you. *Knowledge Quest, 43*(2), 64-70. Retrieved from ERIC database (EJ1045948)

Rees, P., Booth, R., & Jones, A. (2016). The emergence of neuroscientific evidence on plasticity: Implications for educational practice. *Educational & Child Psychology, 33*(1), 8-19.

Reid, J., (2008). The resilient leader: Why EQ matters. *Ivey Business Journal, 72*(3), 1-7. Retrieved from https://iveybusinessjournal.com/publication/the-resilient-leader-why-eq-matters/

Rivers, S. E., Brackett, M. A., Reyes, M. R., Mayer, J. D., Caruso, D. R., & Salovey, P. (2012). Measuring emotional intelligence in early adolescence with the MSCEIT-

YV: Psychometric properties and relationship with academic performance and psychosocial functioning. *Journal of Psychoeducational Functioning, 30*, 344-366. doi:10.1177/0734282912449443

Ross, D. J., & Cozzens, J. (2016). The principalship: Essential core competencies for instructional leadership and its impact on school climate. *Journal of Education and Training Studies*, *4*(9), 162-176. doi:10.11114/jets.v4i9.1562

Saldaña, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage.

Schachter, R. (2012, December). Neuroscience in schools: Improving learning capacity for young students. *District Administration, 48*(11), 40-45. Retrieved from http://www.nxtbook.com/nxtbooks/pmg/da1212/index.php

Schenck, J., & Cruickshank, J. (2015). Evolving Kolb: Experiential education in the age of neuroscience. *Journal of Experiential Education, 38*(1), 73-95. doi:10.1177 /1053825914547153

Shaughnessy, M. F. (2016). An interview with Marcia Tate: Formative assessment and brain-based learning. *Journal of Education and Learning, 10*, 204-207. doi:10 .11591/edulearn.v10i3.3988

Shen, J., Cooley, V., Ma, X., Reeves, P., Burt, W., Rainey, M., & Yuan, W. (2012). Data-informed decision making on high-impact strategies: Developing and validating an instrument for principals. *Journal of Experimental Education, 80*(1), 1-25. doi:10.1080/00220973.2010.550338

Shenton, A. K. (2003). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 63-75. doi:10.3233/efi-2004-22201

Sigman, M., Peña, M., Goldin, A. P., & Ribeiro, S. (2014). Neuroscience and education: Prime time to build the bridge. *Nature Neuroscience*, *17,* 497-502. doi:10.1038 /nn.3672

Sisman, M. (2016). Factors related to instructional leadership perception and effect on instructional leadership on organizational variables: A meta-analysis. *Educational Sciences: Theory & Practice, 16*, 1761-1787. doi:10.12738/estp.2016.5.0172

Smeyers, P. (2016). Neurophilia: Guiding educational research and the educational field? *Journal of Philosophy of Education*, *50*(1), 62-75. doi:10.1111/1467-9752.12173

Sparks, S. (2013, January 4). Social-emotional needs entwined with students' learning security. *Education Week, 32*(6), 16-21. Retrieved from https://www.edweek.org /ew/articles/2013/01/10/16environment.h32.html

Spradley, J. (1980). *Participant observation*. Fort Worth, TX: Harcourt Brace Jovanovich.

Taylor-Powell, E., & Renner, M. (2003*). Analyzing qualitative data.* Madison: Board of Regents of the University of Wisconsin System. Retrieved from https://learningstore.uwex.edu/assets/pdfs/g3658-12.pdf

Tokuhama-Espinosa, T. (2008). *The scientifically substantiated art of teaching: A study in the development of standards in the new academic field of neuroeducation (mind, brain, and education science)* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (AAI3310716)

Tokuhama-Espinosa, T. (2011). *Mind, brain, and education science.* New York, NY: Norton.

Tokuhama-Espinosa, T. (2011). What mind, brain, and education (MBE) science can do for teaching. *New Horizons*, *9*(1). Retrieved from http://jhepp.library.jhu.edu/ojs/index.php/newhorizons/article/view/31/29

Tokuhama-Espinosa, T. (2012). What neuroscience says about personalized learning. *Educational Leadership, 69*(5), 1-4. Retrieved from http://www.ascd.org/publications/educational-leadership/feb12/vol69/num05/What-Neuroscience-Says-About-Personalized-Learning.aspx

Tommerdahl, J. (2010). A model for bridging the gap between neuroscience and education. *Oxford Review of Education*, *36*(1), 97-109. doi:10.1080/03054980903518936

Toth, P., & Farmer, T. (2017). Brain hemispheric characteristics and leadership style of school superintendents. *National Forum Journals.* Retrieved from http://www.nationalforum.com

U.S. Census Bureau. (2018). *Data.* Retrieved from https://www.census.gov/data.html

Urick, A., & Bowers, A. J. (2014). The impact of principal perception on student achievement climate and achievement in high school: How does it measure up? *Journal of School Leadership, 24*, 386-414. doi:10.1177/105268461402400207

Uzezi, J., & Jonah, K. (2017). Effectiveness of brain-based learning strategy on students' academic achievement, attitude, motivation and knowledge retention in electrochemistry. *Journal of Education, Society and Behavioral Science, 21*(3), 1-13. doi:10.9734/jesbs/2017/34266

Valiente, C., Swanson, J., & Eisenberg, N. (2011). Linking student emotions and academic achievement: When and why emotions matter. *Child Development Perspectives, 6*(2), 129-135. doi:10.1111/j.1750-8606.2011.00192.x

Vyas, K., & Vashishtha, K. C. (2013). Effectiveness of teaching based on brain research with reference to academic achievement of secondary school students. *International Journal of Students Research in Technology & Management, 1*, 383-397.

Wang, C., & Burris, M. A. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Education & Behavior*, *24*, 369-387. doi:10.1177/109019819702400309

Waree, C. (2017). An increasing of primary school teachers' competency in brain-based learning. *International Education Studies, 10*, 176-184. doi:10.5539/ies.v10n3p176

Wilson, D., Conyers, M., & Rose, K. (2015). Rethinking learning potential. *Independent School*, *75*(1), 50-54.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Thousand Oaks, CA: Sage.

Zadina, J. N. (2015). The emerging role of educational neuroscience in education reform. *Psicologia Educativa*, *21*(2), 71-77. doi:10.1016/j.pse.2015.08.005

Zambo, D., & Zambo, R. (2011). Teacher beliefs about neuroscience and education. *Teaching Educational Psychology*, *7*(2), 25-41. Retrieved from ERIC database. (EJ955550)

Zenkov, K., & Harmon, J. (2009). Picturing a writing process: Photovoice and teaching writing to urban youth. *Journal of Adolescent & Adult Literacy*, *52,* 575-584. Retrieved from https://www.jstor.org/stable/20468411

APPENDICES

Appendix A

Columbus State University IRB Approval

From: **CSU IRB** <irb@columbusstate.edu>
Date: Thu, Jan 24, 2019 at 4:22 PM
Subject: Exempt Approval Protocol 19-020
To: Tami Godman [Student] <godman_tami@columbusstate.edu>, Robert Waller <waller_robert1@columbusstate.edu>
Cc: CSU IRB <irb@columbusstate.edu>

Institutional Review Board
Columbus State University

Date: 1/24/19
Protocol Number: 19-020
Protocol Title: Brain Based Learning and Education: The Impact of Principal Perception of Brain Based Learning
Principal Investigator: Tami Godman
Co-Principal Investigator: Robert Waller

Dear Tami Godman:

The Columbus State University Institutional Review Board or representative(s) has reviewed your research proposal identified above. It has been determined that the project is classified as exempt under 45 CFR 46.101(b) of the federal regulations and has been approved. You may begin your research project immediately.

Please note any changes to the protocol must be submitted in writing to the IRB before implementing the change(s). Any adverse events, unexpected problems, and/or incidents that involve risks to participants and/or others must be reported to the Institutional Review Board at irb@columbusstate.edu or (706) 507-8634.

If you have further questions, please feel free to contact the IRB.

Sincerely,

Amber Dees, IRB Coordinator

Institutional Review Board
Columbus State University

Appendix B

Letters of Cooperation

DATE: October 3, 2018

TO: Tami Godman
[redacted] Elementary School

FROM: [redacted]
Director of Professional Learning

SUBJECT: **RESEARCH APPROVAL REQUEST**

Your request to conduct research for your graduate program at Columbus State University is approved. The purpose of your study, *"Brain Based Learning and Education: The Impact of Principal Perception of Brain Based Learning",* will be to examine the association between the principal's perceptions of brain-based learning and the implementation of instruction at the school. The timeframe for this research study is one year from the date of system approval.

Thank you for submitting your IRB, research proposal, focus group guide, interview questions, and the executive director approval letter.

Please keep in mind that you will be responsible for compiling the data for your research. The staff at the participating elementary schools and the Departments of Assessment & Accountability and Technology Services is unable to compile data for your research. Board policy also prohibits the use of system email for personal research. Please also remember student and teacher anonymity is of utmost priority for this research project.

I have attached to this approval e-mail the [redacted] County Schools Requirements for Conducting Research.

I wish you the best as you work toward earning your graduate degree. Please let me know if I may be of any assistance to you again in the future.

September 18, 2018

[redacted]

Director of Professional Learning

[redacted] County Board of Education

RE: Brain-Based Learning and Education: The Impact of Principal Perception of Brain-based Learning

Dear Ms. [redacted]:

Please be advised that Tami Goldman, Principal at [redacted] Elementary School, has my permission to conduct research involving the impact of principals' perceptions of brain-based learning. The purpose of this study is to examine the association between the principal's perceptions of brain-based learning and instruction. A case study focus group interview session and individual interviews will be conducted by Dr. [redacted] at [redacted] Elementary School and selected elementary schools. Be examining the research and the guiding questions, perceptions will be evaluated and patterns and practices within a variety of schools will be determined. The findings will offer the educational field insight on the impact principals' perceptions have on brain-based learning to improve student learning and teaching practices. The principals' philosophies and experiences will guide this study to determine the impact on brain-based learning.

Sincerely,

[redacted]

Executive Director for Elementary Operations

Appendix C

Recruitment Letters

Date

Dear Principal,

I am a doctoral candidate at Columbus State University. I am examining the association between the principal's perceptions of brain-based learning and instruction. I am contacting you to see if you would be willing to participate in this research study.

To collect data for this research, a focus group interview session will be conducted at [redacted] Elementary by Dr. [redacted]. This interview session will be conducted by Dr. [redacted] at [redacted] Elementary School after school hours. This session will last around an hour to an hour and a half and will include questions to examine perceptions of brain-based learning. In addition, individual interviews may be conducted. These interviews will take place at the selected principal's school and will last around forty-five to sixty minutes.

Interviews will be recorded on a password laptop and a digital recording device. All participant responses will be kept confidential and coded so no information is attributed to you. Participation is strictly voluntary.

The findings will offer the educational field insight on the impact principals' perceptions have on brain-based learning to improve student learning and teaching practices. Your responses will guide this study to determine the impact on brain-based learning.

To join the study, please complete the attached informed consent form and return by scanning/attaching it to the sending email address (godman_tami@columbusstate.edu). The informed consent form must be printed, signed, and dated.

If you have questions or concerns about this research study, please feel free to contact me at [redacted]. Once the completed attachment is received, you will be contacted concerning data collection and scheduling.

Thank you in advance for your assisting with this important research study.

Sincerely,

Tami Godman
Doctoral Student, Columbus State University

COLUMBUS STATE UNIVERSITY

Date

Dear Principal,

As a principal in this middle Georgia County, you are asked to participate in a research study being conducted by Tami Godman, a doctoral student at Columbus State University.

The purpose of this study is to examine the association between the principal's perceptions of brain-based learning and instruction.

If you are willing to participate in the study, which consists of a focus group interview session and a possible individual interview session, please respond to this email request by attaching the informed consent form to the sending email address (godman_tami@columbusstate.edu). The informed consent form must be printed, signed, and dated. Participation is voluntary and all information collected will be coded to protect your confidentiality. Nothing you contribute to the study will be attributed to you.

The results will offer the educational field insight on the impact principals' perceptions have on brain-based learning to improve student learning and teaching practices. Your responses will guide this study to determine the impact on brain-based learning.

If you have questions or concerns about this research study, please feel free to contact me at [redacted]. Once the completed attachment is received, you will be contacted concerning data collection and scheduling.

Sincerely,

Tami Godman
Doctoral Student, Columbus State University

Appendix D

Informed Consent Form: Focus Group

COLUMBUS STATE UNIVERSITY

You are being asked to participate in a research project conducted by Tami Godman, a student in the Curriculum and Leadership Doctoral Program at Columbus State University. This research is being conducted under the supervision of Dr. Robert Waller.

I. Purpose:

The purpose of this study is to examine the association between the principal's perception of brain-based learning and the implementation of instruction at the school. The research design will include a qualitative case study and examine the perceptions of themes of mind, brain, and education among principals.

II. Procedures:

All elementary principals in the Middle Georgia County will be contacted about participating in the study. Once the researcher obtains a consent form from all participants who agree to participate, a sample of principals will be selected for the focus group interview session. Participants will be given pseudonyms and will not be identified in any interview sessions. All responses will be kept confidential. The researcher will contact each participant concerning the date and time for the interview. The focus group interview will last approximately 60-120 minutes. The participants will be asked questions about their thoughts and perceptions regarding brain-based learning and education. Dr. Pat Witt will conduct all interviews using a lap top device and a digital audio recorder. These sessions will be transcribed. The data collected will not be used in any further projects.

III. Possible Risks or Discomforts:

There are no possible risks or discomforts for participants in this study.

IV. Potential Benefits:

This case study will measure the individual's knowledge, beliefs, and other information concerning brain-based learning. The knowledge of these common elements will be useful in determining any patterns found between various principals and the impact the leaders have based on the perspective of brain-based learning as it relates to education.

V. Costs and Compensation:

There is no cost or compensation associated with participants.

VI. Confidentiality:

The data collected will be indirectly coded and no participant identifiers will be included in the results. All data will be password protected and responses will not be linked to the participants. All physical documents will be locked in a secure safe for three years. No one will have access to the data except the principal investigator. At the end of the three years, the documents will be destroyed by shredding. All electronic files will be kept on a password secure device. At the end of the three years, the electronic documents will be destroyed through Secure Erase.

VII. Withdrawal:

Participation in this study is strictly voluntary. Participants may withdraw from the study at any time, and withdrawal will not involve penalty or loss of benefits.

For additional information about this research project, you may contact Tami Godman at [redacted], or godman_tami@columbusstate.edu. If you have questions regarding your rights as a research participant, you may contact the Columbus State University Institutional Review Board (IRB) at irb@columbusstate.edu.

I have read this Informed Consent Form. If I had any questions, they have been answered. By signing this form, I agree to participate in this research study. I am at least 18 years of age or older.

____ __________________

Signature of Participant Date

Appendix E

Focus Group Protocol

1. What is your definition of brain-based learning?
2. What is the role of brain-based learning activities in the curriculum at your school?
3. Give me some examples of brain-based learning activities at your school.
4. What is the role of the principal in regard to brain-based learning activities in the school?
5. What brain-based strategies are used in classrooms at your school?
6. How can practitioners apply scientific knowledge related to recent research findings in neuroscience in the classroom?
7. What professional learning are teachers receiving concerning brain-based learning?
8. In what ways do you think your role in brain-based learning impacts the performance of your students?
9. How do brain-based learning activities influence student performance?
10. What is the role of teachers in implementing student achievement through brain-based learning activities and strategies?
11. Is there anything else you would like to add regarding brain-based learning and education?

Appendix F

Informed Consent Form: Individual Interview

You are being asked to participate in a research project conducted by Tami Godman, a student in the Curriculum and Leadership Doctoral Program at Columbus State University. This research is being conducted under the supervision of Dr. Robert Waller.

I. Purpose:

The purpose of this study is to examine the association between the principal's perception of brain-based learning and the implementation of instruction at the school. The research design will include a qualitative case study and examine the perceptions of themes of mind, brain, and education among principals.

II. Procedures:

All elementary principals in the Middle Georgia County will be contacted about participating in the study. Once the researcher obtains a consent form from all participants who agree to participate, a sample of principals will be selected for the follow-up individual interview session. Participants will be given pseudonyms and will not be identified in any interview sessions. All responses will be kept confidential. The researcher will contact each participant concerning the date and time for the interview. The individual interview will last approximately 45-60 minutes. The participants will be asked questions about their thoughts and perceptions regarding brain-based learning and education. Dr. Pat Witt will conduct all interviews using a lap top device and a digital audio recorder. These sessions will be transcribed. The data collected will not be used in any further projects.

III. Possible Risks or Discomforts:

There are no possible risks or discomforts for participants in this study.

IV. Potential Benefits:

This case study will measure the individual's knowledge, beliefs, and other information concerning brain-based learning. The knowledge of these common elements will be useful in determining any patterns found between various principals and the impact the leaders have based on the perspective of brain-based learning as it relates to education.

V. Costs and Compensation:

There is no cost or compensation associated with participants.

VI. Confidentiality:

The data collected will be indirectly coded and no participant identifiers will be included in the results. All data will be password protected and responses will not be linked to the participants. All physical documents will be locked in a secure safe for three years. No one will have access to the data except the principal investigator. At the end of the three years, the documents will be destroyed by shredding. All electronic files will be kept on a password secure device. At the end of the three years, the electronic documents will be destroyed through Secure Erase.

VII. Withdrawal:

Participation in this study is strictly voluntary. Participants may withdraw from the study at any time, and withdrawal will not involve penalty or loss of benefits.

For additional information about this research project, you may contact Tami Godman at [redacted], or godman_tami@columbusstate.edu. If you have questions regarding your rights as a research participant, you may contact the Columbus State University Institutional Review Board (IRB) at irb@columbusstate.edu.

I have read this Informed Consent Form. If I had any questions, they have been answered. By signing this form, I agree to participate in this research study. I am at least 18 years of age or older.

____ ________________

Signature of Participant Date

Appendix G

Interview Protocol

1. How would you describe brain-based learning at your school?
2. Could you please describe to me what I would see in a classroom in your school that was implementing brain-based learning?
3. Can you give me some examples of how this has or has not influenced student learning?
4. Can you tell me more about the professional learning your teachers are receiving?
5. Can you tell me more about the professional learning you are receiving?
6. How would you describe your role with the implementation of brain-based learning in your school?
7. In what ways does your influence as a principal have on brain-based learning at your school?
8. In your opinion, does brain-based learning effect student achievement?
9. Is there anything else you would like to add regarding brain-based learning and education?

Appendix H

Researcher National Institutes of Health Certificates

Certificate of Completion

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

Date of completion: 02/01/2017.

Certification Number: 2307085.

Certificate of Completion

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

Date of completion: 03/14/2017.

Certification Number: 2351150.

Certificate of Completion

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

Date of Completion: 08/18/2018

Certification Number: 2882383

NIH National Institutes of Health
Office of Extramural Research