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Public School Teachers' Gender, Years of Teaching Experience, Knowledge, and Perceptions as Predictors of Their Implementation of Brain-Based Learning Practices in K-12 Classrooms

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ABSTRACT

PUBLIC-SCHOOL TEACHERS' GENDER, YEARS OF
TEACHING EXPERIENCE, KNOWLEDGE, AND
PERCEPTIONS AS PREDICTORS OF THEIR
IMPLEMENTATION OF BRAIN-BASED
LEARNING PRACTICES IN K-12
CLASSROOMS

by

Emmanuel Oduro-Bediako

Chair: Elvin Gabriel

ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

College of Education and International Services

Title: PUBLIC-SCHOOL TEACHERS' GENDER, YEARS OF TEACHING
EXPERIENCE, KNOWLEDGE, AND PERCEPTIONS AS PREDICTORS OF
THEIR IMPLEMENTATION OF BRAIN-BASED LEARNING PRACTICES
IN K-12 CLASSROOMS

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Date completed: May, 2019

Problem

With the introduction of a national curriculum, content standards, and federally mandated assessment; involuntarily teachers have adopted test-based teaching approaches in the classroom. Concurrently, researchers are celebrating brain-based learning because of breakthroughs in neuroscience and cognitive psychology and are promoting it as a watershed teaching opportunity. This has created a gap between research and practice, meaning that teachers' ability to implement brain-based learning has been affected negatively.

Method

In a correlational design, a non-experimental quantitative study was conducted to examine a sample ($N = 422$) of teachers from K-12 schools within the United States public school system. The study adopted the analytical tool, Multiple Linear Regression, to analyze the null hypothesis that public-school teachers' gender, years of teaching experience, knowledge about brain-based learning, and perceptions of brain-based learning are not significant predictors of their implementation of brain-based learning practices in K-12 classrooms.

Results

The results showed that the prediction model was statistically significant, $F(4, 417) = 258.569, p < .001$, and accounted for 71% of the variance of implementation of brain-based learning practices ($R^2 = .713$, Adjusted $R^2 = .710$). Implementation of brain-based learning practices was found to be significantly predicted by perception ($\beta = .541, t = 10.623, \text{sig.} = .000$) and by knowledge ($\beta = .337, t = 6.586, \text{sig.} = .000$), with perception predicting K-12 teachers' implementation of brain-based learning practices in classroom 1.6 times more than knowledge. However, the results show that years of teaching experience and gender were not significant predictors of K-12 teachers' implementation of brain-based learning practices in the classroom.

Conclusion

From this evidence, it was concluded that, in general, K-12 teachers will be more willing to implement brain-based learning practices in the classroom provided their perceptions and knowledge about it are improved. Another conclusion is that improving

teachers' perceptions and knowledge about brain-based learning, as opposed to emphasizing federally mandated test scores, are current motivating factors for improvements in teaching. Thus, in order to revamp teaching within K-12 public schools, reformers should seek to improve teachers' perceptions and knowledge as necessary components of the implementation of brain-based learning processes with primary emphasis on teachers' perception of brain-based learning practices.

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August 2019

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DEDICATION

I am humbled by the scriptural passage in Luke 17:10 that says, “So likewise you, when you have done all those things which you are commanded, say, ‘We are unprofitable servants. We have done what was our duty to do.’” Within this backdrop, my foremost thanks and praise go to God for providing me strength, knowledge, wisdom, and a supportive loving family.

At the human level, I dedicate this dissertation to my wife, Connie, and my children, Deborah and Enoch, for their unwavering support, love, prayers, and encouragement through this learning experience. I also dedicate this dissertation to my deceased mother Agnes Dentah, and my grandmother, Mary Akoto, for their exceptional training and for instilling in me the hard work and excellence needed to accomplish this academic goal.

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LIST OF ABBREVIATIONS

BBL	Brain-based Learning
BBLSQ	Brain-based Learning Survey Questionnaire
EEG	Electroencephalography
ERP	Event-Related Potential
fMRI	Functional Magnetic Resonance Imaging
IRB	Institutional Research Board
K-12	Kindergarten through 12 th grade
MLR	Multiple Linear Regression
MRI	Magnetic Resonance Imaging
NEA	National Education Association
PET	Positive Emission Tomography
TMS	Transcranial Magnetic Stimulation

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CHAPTER 1

INTRODUCTION

Background

Recent breakthroughs in medical research, particularly in neuroscience and cognitive psychology, have made it easier to explore teaching and learning from the standpoint of brain function and processes. Using a combination of brain imaging techniques such as magnetic resonance imaging (MRI), positive emission tomography (PET), functional magnetic resonance imaging (fMRI) and brain recording techniques like electroencephalography (EEG), event-related potential (ERP), and transcranial magnetic stimulation (TMS), cognitive neuroscientists have linked cognitive processes such as attention, memory, and to pattern recognition, knowledge representation, language, problem-solving, reasoning, and decision-making (Rehman & Bokhari, 2011, Jensen 2000, 2005; Klinek, 2009; Mansy, 2014). This intersection between medical and educational research has led to what has become known as the theory of brain-based learning (BBL) (Rehman & Bokhari, 2011; Zadina, 2015).

Although research in the discipline of BBL remains relatively young compared to other curricular products, it has become a watershed discovery for the learning and teaching process. From this discovery, experts have redefined learning as a complex rewiring of the brain embroiled in cognitive processes such as sensation, consciousness, attention, perception, and memory (Zadina, 2014, 2015; Zull, 2002). Investigating its

impact in the classroom, scholars have characterized BBL as an effective teaching method that leads to greater achievement among students (Avaci & Yagbasani, 2004; D'Amato & Wang, 2015; Davis & D'Amato, 2014; Duman, 2006; Mercer, 2016; VanDevender & Rice., 1984; Waters, 2005). Accordingly, experts have argued that instruction becomes more effective when designed after the natural ways the brain learns (Caine & Caine, 1991; Davis & D'Amato, 2014; Jensen, 2005, 2008; Wolfe, 2001). With this discovery, cognitive neuroscientists have affirmed the need for teachers to understand how learners' brains work in order to teach effectively (Jensen 2000, 2005; Klinek, 2009; Mansy, 2014; Sousa, 2011; Snowman, McCown, & Biehler, 2009; Zadina, 2014).

As a watershed curricular process, BBL has gained the attention of many accredited scholars such as University of California, Los Angeles's Renate Nummela Caine and Geoffrey Caine (1994; 1995; 1997; 1999; 2005; 2012); international consultant in educational neuroscience, David A. Sousa (2006; 2011); the classroom strategist, Eric Jensen (2000; 2005, 2008); left-right brain education groundbreaking theorist, Linda Verlee Williams (1983); Ohio State University's scholar Carol A. Lyons (2003); the cognitive neuroscientist and international speaker on brain research and learning Janet Nay Zadina (2014, 2015); international Christian educational psychologist, William R. Yount (2010); and more.

Generally, BBL experts agree that the following 12 overarching principles, designed by Caine and Caine (1997), must remain the cornerstone for BBL:

1. The brain is a parallel processor.
2. Learning engages the entire physiology.
3. The search for meaning is innate.
4. The search for meaning occurs through patterning.

5. Emotions are critical to patterning.
6. The brain processes parts and wholes simultaneously.
7. Learning involves both focused attention and peripheral perception.
8. Learning always involves conscious and unconscious processes.
9. We have at least two different types of memory: A spatial memory system and a set of systems for rote learning.
10. We understand and remember best when facts and skills are embedded in natural, spatial memory.
11. Learning is enhanced by challenge and inhibited by threat.
12. Each brain is unique (pp. 87-96).

Statement of the Problem

Regardless of the many calls from brain education experts for reform and the exhaustive scholarly opportunities created by researchers, problems in the way instruction is conducted have persisted; thus, a gap has existed between research and teacher practice. Historically, teachers have had a meaningful impact on school curriculum. However, with the introduction of national curricula, content standards, and federally mandated assessment, teachers' approach to instruction changed. In fact, to enforce these regulations, teachers are evaluated now based on student test results.

Because these forces have limited teachers' control over what (content) and when (occasion) to teach, involuntarily teachers have adopted test-based teaching approaches in the classroom. Consequently, teachers have less opportunity to base their lesson plans on current research in brain education. This problem has created a gap between research and practice and is a dilemma for policy-makers and educators as well as teachers and students.

Another possible cause of the problem is the strong affinity teachers have for teacher-centered instructional approaches. For years, teachers in American schools have adopted teacher-centeredness as the a-priori approach guiding instruction, because of its

reliance on behavior-management-related strategies such as punishment, timeout, extinction, and spontaneous recovery.

While solutions from this study may not be a panacea for every instructional challenge facing teachers, the goal is to scrutinize those variables underlying teachers' implementation of BBL practices in their classrooms. In this non-experimental quantitative study, a correlational design was conducted to examine approximately 420 public-school teachers from kindergarten through 12th grade (K-12) schools and evaluate how teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL might predict their implementation of BBL strategies in the classroom.

Rationale for the Study

One of the striking characteristics of change is the rate at which people can resist it because of a lack of clarity and a lack of timely responses to broader issues that undercut real decision making. Researchers have shown that true change does not occur until individuals within the system being changed understand the process from both its theoretical and practical standpoints (Fuller, 1969; Hall & Hord, 2011). Evidently, in recent years, although many studies have been conducted, their conclusions have had little impact on teachers' implementation of BBL practices (D'Amato & Wang, 2015; Davis & D'Amato, 2014; Klinek, 2009; Mansy, 2014; Wachob, 2012).

Timperley (2008) has asserted that for teachers to improve their practice in the classroom requires making significant changes which in turn require “multiple opportunities to learn new information and understand its implications for practice” (p.15). Yet, although previous researchers did a comprehensive examination of the

subject, their investigations treated gender and years of teaching experience as mere demographics and not as distinct variables (Klinek, 2009; Mansy, 2014; Wachob, 2012). In acknowledgement of Timperley's assertion and a desire to thoroughly examine teachers' implementation of BBL from the standpoint of the variables that might impede it, this study included gender and years of teaching experience as distinct independent variables.

For the results of a study to be reliable, the variables being investigated must be backed by theory. Accordingly, treating gender and years of teaching experience as mere demographics without sufficient theoretical support leaves the findings unreliable. Meanwhile, according to Creswell (2012), teachers examine first the object to be implemented in the classroom, then compare their object with researched alternatives, before deciding the benefits research might bring to the task confronting them.

McMillan & Schumacher (2010) have shown that teachers' implementation of BBL practices in the classroom will improve, provided they become exposed to more intellectual debate that fosters more professional collaboration and facilitates other situations which can provide forums where participants can define and accept scientific knowledge. In fact, McMillan & Schumacher (2010) have noted that a study does not contribute meaningfully to present knowledge until its findings have been widely distributed and recognized by the professional peer group targeted by the study. To facilitate this purpose, this study was designed to give teachers an adequate theoretical basis toward their implementation of BBL practices.

This study assumes that immersing gender and years of teaching into an appropriate theoretical perspective would lend a fresh basis for comparing the role of

gender with existing findings. Such an expansive function was referenced in Creswell's (2012) definition of theory as "the language that allows researchers to move from observation to observation, making sense of similarities and difference," affirming the true significance of theory (p. 9). Arguably, improving teachers' knowledge and perceptions about the impact of their gender and years of teaching experience on their implementation of BBL practices could serve as a strong self-evaluation tool not only for teachers, but for all decision makers about educational processes.

Purpose of the Study

The purpose of this study was to investigate whether teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are predictors of their implementation of BBL practices in K-12 classrooms.

Significance of Study

The study was intended to present a unifying framework within which the views of teachers and researchers could be reconciled in the context of classroom instruction. Aside from its comparative purposes, this study was intended to add to the theoretical body of knowledge in the field of education, benefitting policy-makers and educators, as well as improving teacher practice in the classroom. Most of the research about teachers' implementation of BBL practices limits the investigation to a few variables. In this study two of the variables, namely, teachers' gender and years of teaching experience were used as independent variables, which has not occurred in previous studies.

This study was also intended to offer stakeholders and decision-makers a new window to observe the nature of teacher practices regarding implementation of BBL in

the light of the variables investigated here. Additionally, a goal was to help open new pathways for improving research, policies, and classroom practices. Undoubtedly, the knowledge accrued from this study will be useful in developing effective basic strategies and procedures for effecting educational change. Ultimately, improving teacher effectiveness and competence will help improve student learning and achievement.

Research Question

This study answers the question, what is the role of public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL as predictors of their implementation of BBL practices in K-12 classrooms?

Hypotheses

Research Hypothesis

H1: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are significant predictors of their implementation of BBL practices in K-12 classrooms.

Null Hypothesis

H0: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are not significant predictors of their implementation of BBL practices in K-12 classrooms.

Limitations

The investigator's lack of control over the candor with which teachers would respond to the questions was assumed to be a potentially uncontrollable limitation of this study. Although the survey questionnaires used in this study were clear and logical, the investigator had no control over the true opinion of the participants. Hence, the study had no way of verifying the intentions of teachers who responded to the questions. Eventually, the study relied on the assumption that responders would be genuine in answering the questions.

Delimitation

This study was delimited to teachers within the public school system in K-12 classrooms.

Theoretical Framework

Introduction

The current study was based on two theoretical perspectives, namely: constructivist learning theory and the connectionist approach to learning. The following synopsis synthesizes these two perspectives and how they underpin the theory of BBL as a whole.

Constructivist Theory of Learning

Fundamentally, constructivism is a theory that involves both knowledge and learning. Fosnot and Perry (2005) define constructivism in terms of "what knowing is and how one comes to know" (p. 1). Generally, experts view constructivist learning as an

active and adaptive process in which students construct new concepts based on their present and past knowledge and experiences (Brunner, 1960; Burnett, 2010; Caine, Caine, & McClintic, 2002; Rorty, 1991; Webb, Metha, & Jordan, 2007).

Philosophically, constructivism appears to stand in stark contrast to objectivism, which holds that teaching the learner about reality is not adequate until the learner is able to replicate the content and structure of what they have learned in their thinking (Jonassen, 1991). The traditional objectivist theory of knowledge posits that knowledge and truth (that is, reality) exist outside the mind of the individual. On the contrary, constructivist theory holds that knowledge and truth do not exist outside of the learner's mind; instead, knowledge is a construct dependent upon human mental activity and is determined by the knower (Jonassen, 1991). Thus, constructivists describe knowledge acquisition as a mental activity that involves internal coding and structuring by the learner (Snowman, et al., 2009).

Therefore, in constructivism, knowledge does not exist independent of the learner rather knowledge is constructed in the head as learners reorganize their experiences and cognitive structures (Piaget, 1970; Jonassen, 2001). Hence, constructivists argue that knowledge constitutes a reflection of the outcomes of mental interactions with the environment. In fact, constructivists believe that knowledge is derived from interactions between learners and their environments. As such, constructivists esteem collaboration, learner autonomy, generativity, reflectivity, and active engagement. Yet practically, constructivism does not deny objectivity, rather it allows a connection between the learner and the objective world (Moallem, 2001).

Due to the above, constructivists view learning not as a stimulated-response but rather as an active and internal constructing process that makes connections between learners and their environments (Yıldırım, 2014). For constructivists, meaning is not discovered but rather constructed. In other words, constructivists hold that people construct their own meaning in multiple ways, even in relation to the same phenomena. After a thorough examination of how meaning is constructed, Marlowe and Page (2005), concluded that in constructivism, learning is primarily about (1) constructing knowledge, not receiving it; (2) understanding and applying information, not recalling it; (3) thinking and analyzing, not accumulating and memorizing; and (4) being active, not passive.

Experts believe that the constructivist theory of learning and BBL theory intersect in many ways (Barkley, 2010; Gülpınar, 2005; Kahveci & Ay, 2008). First, researchers trace both constructivist and BBL to Socratic methods (Boghossian, 2006; Brooks & Brooks, 1993; Erdem & Demirel, 2002), Jerome Bruner's discovery learning (Snowman, et al., 2009), Piaget's cognitive development (1970, 1977), Bandura's social cognitive constructivism (Bandura, 1977; Schunk, 2007; Zimmerman, 2000), and Vygotsky's negotiated meaning (Perkins, 1999; Snowman, et al., 2009; Vygotsky, 1978, 2016). In fact, aside from their common proponents, Germinario & Cram (1998) have argued that both constructivism and BBL have foundational roots in psychology and philosophy.

Second, experts believe that the constructivist theory and BBL overlap in their philosophical assumptions (Barkley, 2010; Bruer, 1997; Wilber, 2000), teaching approaches (Brooks & Brooks, 1993; Gülpınar, 2005; Jensen, 2008), cognition and real-life experiences (Ozden & Gultekin, 2008), instructional approaches (Kahveci & Ay, 2008), and psychology of learning (Erlauer, 2003). Philosophically, constructivists

believe that meaning exists both inside and outside the learner. Hence, constructivists espouse that meaningful learning occurs when learners actively try to make sense of reality by constructing an interpretation of the world (Geary, 1995; Mayer, 2004; Riegler & Quale, 2010). Similarly, BBL teaches that cognition or knowledge resides both within the learner and outside him. In fact, Caine and Caine (1994) have argued that the search for meaning, aside from being innate, occurs through patterning.

Third, constructivism and BBL intersect in terms of their foundational principles. Jennings and Caulfield (1997) posit that the foundational elements of BBL, including active and meaningful learning, feedback, and safe or non-threatening classroom environments are congruent with constructivist pedagogy. Kahveci and Ay (2008) have also argued that BBL theory “explains the methods used for teaching in a cause-effect relationship” (p. 127) of constructivist learning principles. Consequently, Kahveci and Ay (2008) identified five instructional principles common to constructivism and BBL, namely: (1) meaningful learning, (2) individual differences in learning, (3) multiple representations in learning, (4) personal and environmental factors in learning, and (5) affective components in learning.

After a careful comparative study of constructivism and the theory of BBL, Kahveci and Ay (2008) summarized these 5 theoretical underpinnings for both constructivist learning and BBL in the diagram Figure 1.

Fourth, when used as instructional approaches, both constructivist and BBL focus on learners’ cognitive changes rather than on behavioral changes (Fosnot & Perry, 2005). Hence in the classroom, both constructionism and BBL promote the learner, instead of the teacher, as the center of instruction and controller of the learning process and

environment (Jacobsen, Eggen, & Kauchak, 2009). Thus, in both constructivism and BBL, the principal focus of the learning process is not so much on what learners know but about how they acquire knowledge (Jonassen, 1991). In this context, Snowman, et al., (2009) have maintained that “the focus of cognitive learning theory is the mind and how it works” (p. 373). In this sense, the learner is personified as an active contributor to the learning process.

These overlapping implications include the encouragement of students to engage in meaningful learning and to construct understanding based on previous knowledge (Barkley, 2010). In fact, many scholars have concluded that a learning environment designed to foster constructivist pedagogy does bring positive effects to creativity (James, Gerard, & Vagt-Traore, 2010; Tezci & Gürol, 2003), meta-cognitive skills (Jager, Jansen, & Reezigt, 2005; Lam, 2009), critical thinking (Maypole & Davies, 2001), and problem solving (Bay, Bagceci, & Cetin, 2012; Wilson, 2010).

Figure 1. The overlapping principles between brain-based and constructivist learning approaches.

In consideration of such vast implications of constructivist-based learning environment on student achievement, Brooks and Brooks (1993) suggest that constructivist practices must be made imperative. More investigators are now urging teachers to implement constructivist approaches such as BBL in the classroom (Jensen, 2008; Posner & Rothbart, 2005; Sousa, 2011). Despite its effectiveness for teacher practices, the literature has shown lower implementation of constructivism by K-12 teachers within the public school system; this is a result of attenuating factors such as teachers' gender differences (Osborn, Abbot, Broadfoot, Croll, & Pollard, 1996); insufficient teacher knowledge of constructivist practices (Brophy, 1998; Good & Brophy, 2000; Rowan, Correnti, & Miller, 2002; Wentzel, 1997, 1998), and thwarted teacher perceptions of constructivist practices (Callahan, Clark, & Kellough, 2002; Edwards, 2002; Ertmer, 2005; Goodlad, 2004, Marks, 2000; McDermott, Mordell, & Stoltzfus, 2001; Pajares, 1992; Roderick & Engel, 2001; Weiss & Pasley, 2004), and years of teaching experience (Bonomo, 2017; Caliskan, 2015; Koc, 2013; Ridley, 2012; Sahin, 2013; Turan & Erden, 2010; Uredi, 2013, 2014; Winter, 2015). Since BBL explains the theory of constructivism, researchers have found similar drawbacks in the implementation of constructivism in public K-12 schools (Caine & Caine, 1994; Jensen, 2008; Klinek, 2009; Wachob, 2012).

The Connectionist Approach

A second paradigm that underpins the theory of BBL is the connectionist approach of cognition. Scholars have traced the birth of connectionism to earlier theories of mental processes predominant at the time of Freud (1895), James (1890), Meynert (1884), and Spencer (1872). Although its actual history dates back to the 1950s, experts

agree that it was only at the beginning of the 1980s that the connectionist approach gained extensive recognition.

Historically, until the connectionist approach was fully conceptualized, BBL experts had explained cognition based on the information processing approach. By contrast, the information process model regards cognition as information (i.e. what we hear, read about) travelling across a system or the mind (Galotti, 2014). As such, information processing experts, according to Galotti, regard cognitive abilities as a “system of interrelated capacities that can be taught” (p. 15). Such interpretation, said Galotti, assumes that “information is received, stored, recorded, transformed, retrieved, and transmitted in stages, and that it is stored in specific places while being processed” (p. 15). The assumption that information is processed in stages, coupled with the assumption that human cognitive abilities can be taught, became the basis for the concept that human cognition is analogous to computerized processing of information.

However, by the 1980s cognitive scientists saw the need to replace the computer metaphor or information processing model with a brain metaphor, the connectionist approach or a parallel-distributed processing (PDP) model (Galotti, 2014, Feldman & Ballard, 1982; Hinton, McClelland & Rumelhart, 1986; Rumelhart & McClelland, 1986). Despite the resemblance between human cognition and computerized processing of information, experts differentiated cognition as a network of connections among simple but multiple processing units similar to neurons (Galotti, 2014; McClelland, 1988). Differentiating between the two, Galotti noted, “Like the information-processing approach, connectionism draws from structuralism an interest in the elements of cognitive functioning. However, whereas the information processor approach looks to

computer science, connectionists look to cognitive neuropsychology and cognitive neuroscience for information to help them construct their theories and models” (p. 18). Galotti’s allusion makes the difference clearer: the information processing and connectionist approaches are rooted in structuralism; but separately, the connectionist approach is rooted in cognitive neuroscience. Thus, BBL theory relates more to the connectionist approach than to the information-processing approach, given that BBL originated from cognitive neuroscience.

The connectionist approach assumes that information flowing from one process to another is not controlled by a central or single processing unit, as was previously hypothesized by the information processing experts (Galotti, 2014). In fact, Dawson (1998) has shown that different patterns of activation underpin the various cognitive processes. Aside from its ability to embrace a wider range of models, Galotti (2014) argues that the connectionist model is “more consistent with the way the brain works than the information processing approach” (p. 19). This is due in part to the fact the connectionist model draws from multiple sources including structuralism, cognitive neuropsychology, and cognitive neuroscience theories (Galotti, 2014).

Mostly, experts point out few advantages of the connectionist approach over the information processor approach. For instance, while the information processing approach suggest that cognition occurs serially, the connectionist model teaches that cognition occurs in parallel (Galotti, 2014). Bruning, Schraw, and Norby (2011) noted that unlike most computer programs, our cognitive systems can function under multiple limitations by acting simultaneously in parallel and multiple dimensions. Hence, Bruning, et al.,

(2011) acknowledged that the connectionist model of processing information is far stronger than the computer-related information processing model.

In fact, the relationship between connectionism and BBL has been elucidated in multiple cognitive theories. For instance, experts have argued that in order to be effective, connectionist teachers must first understand the behavioral and mental states of their students in addition to the neural processes that underpin cognition (Mareschal et al., 2007; McClelland & Cleeremans, 2009; Rogers & McClelland, 2004). Furthermore, Houghton (2005) has acknowledged that connectionism has been linked to a diverse range of cognitive abilities, including models of memory, attention, perception, action, language, concept formation, and reasoning.

Meanwhile, experts view teachers' gender, years of teaching experience, knowledge about, and perceptions of BBL as key factors that influence teachers' implementation of BBL practices as far as the connectionist model of learning is concerned. For instance, connectionists have suggested gender has a significant impact on judging the effectiveness of instructional animation with evidence that instructional animations can support females more than males (Manouchehri, 2002; Sanchez & Wiley, 2010; Wong, Castro-Alonso, Ayres, & Paas, 2015). Another set of compelling evidence has indicated that males, in this context male teachers, tend to attain higher spatial ability than females (Halpern, 2012; Halpern et al., 2011; Koscik, O'Leary, Moser, Andreasen, & Nopoulos, 2009).

Apart from pointing out the relationship between teachers' gender and their teaching skills, connectionists have accentuated a similar relationship between teachers' knowledge and their choice of instructional approaches. McClelland (1995) has stated

“knowledge in a connectionist system is stored in the connection weights: it is the connections that determine what representation we form when we perceive the world and what responses these representations will lead us to execute” (p. 159). Among other things, McClelland (1995) notes that acquisition of knowledge occurs gradually through experience.

The essence of teachers’ knowledge of instruction has been idealized in teachers’ selection of instructional data. Unlike the connectionist model of learning, in a typically assumed model, experts have argued that teachers randomly select instructional data, either explicitly (Tenenbaum, 1999; Tenenbaum & Griffiths, 2001) or implicitly (Rogers & McClelland, 2004). Unfortunately, such random selection of data makes the assumed model ineffective (Shafte et al., 2014). By contrast, Shafte, et al., reported that “Understanding pedagogical reasoning requires formalizing this process of pedagogical sampling and describing how it affects learning” (p. 56). It can be argued that connectionist teachers are more effective since it allows them to select data more purposefully or rationally, thus enabling them to achieve their goals in teaching.

Thus, although the field is relatively young, Cleeremans & McClelland (1991) have encouraged teachers to be knowledgeable about relevant tenets of connectionism in order to apply them in their classrooms. In fact, experts have reported that in comparison with other animals, humans are the only ones that amass knowledge rapidly over a period of time (Csibra & Gergely, 2006, 2007; Shafte et al., 2014). This, according to Csibra (2007) is due to the unique human ability to interact with and assimilate explicit teaching situations.

Another dominant factor affecting the connectionist model of learning is the lack of understanding regarding teachers' perceptions of the infertile nature of the old model as opposed to the new connectionist model. As in BBL, experts view teachers' perception of the connectionist model learning as highly related to the quality of their practice (Fennema et al., 1996; Polly et al., 2013). In Wilkins' (2008) mind, teacher knowledge, attitudes, and beliefs or perceptions are related to instructional practices. Therefore, researchers argue that before changing their professional practice, teachers normally review the context of teaching in comparison with their own beliefs or perceptions (Caine, Caine, McClintic, & Klimek, 2005; Caulfield, Kidd, & Kocher, 2000; Winters, 2001). The bottom line here is that in order for them to be effective, teachers must reflect on their mental models regarding how to incorporate BBL strategies into their teaching (Caulfield, et al., 2000; Winters, 2001).

Experts also believe that human experience, in general, plays a central role in the connectionist model. In contrast to other traditional cognitive science models, learning in the connectionist models occurs through our experience or repeated exposure to stimuli from the environment (Caine, Caine, McClintic, & Klimek, 2005; Caulfield, Kidd & Kocher, 2000; McClelland & Rumelhart, 1986). This means that people learn through constant exposure to stimuli from the environment.

For instance, dealing with how to improve students' reaction time regarding reading, multiplication, and copying tasks pose a huge challenge for many teachers. Within this milieu, experts have reported that a student learning to read may encounter dyslexia if teachers fail to help the student by providing relative examples of printed words and their meaning (Campbell & Graham, 1985; Shults, 2007). Furthermore,

Graham and Campbell noted that reaction time increases with the increasing size of a multiplication task.

To ease such students' challenges (e.g. with multiplication), Campbell and Graham (1985) noted that teachers may have to provide many examples and offer the learner different ways to contemplate the problem. Shults (2007) also found that a student who is copying information with little understanding or an imprecise reality that does not match the internal concept may experience the same kind of disequilibrium described by Piaget. Here too, connectionists believe that teachers may have to give the learner full target-informative-feedback rather than mere cues to allay the disequilibrium (Fodor & Pylyshyn, 1988; Rumelhart & McClelland, 1986). In Shults' (2007) mind, this points to Piaget's (1970) mindset, which viewed equilibrium as an imbalance between the processes of assimilation and accommodation.

Unfortunately, the student-copyist was unsuccessful because the change accentuated was not useful enough to improve and restore equilibrium. Connectionists believe that a well-informed teacher should understand that closing such a zone of proximity between him/her and the struggling learner is attainable through scaffolding (Fodor & Pylyshyn, 1988; Rumelhart & McClelland, 1986). Furthermore, they argue that these complexities, if not resolved, can impede their willingness to implement BBL.

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Experts also believe that human experience, in general, plays a central role in the connectionist model. In contrast to other traditional cognitive science models, learning in the connectionist models occurs through our experience or repeated exposure to stimuli from the environment (McClelland & Rumelhart, 1986). This means that people learn through constant exposure to stimuli from the environment. Apparently, as far as the connectionist model of learning is concerned, experienced teachers who have had a repeated exposure to BBL practices would learn more about these practices than preservice teachers would. Whether their experience translates into practice is the domain of this study. Generally, experience plays a central role in the connectionist theory of learning. In contrast to other traditional cognitive science models, experts believe that learning in the connectionist models occur through experience (Caulfield, Kidd & Kocher, 2000; McClelland & Rumelhart, 1986).

Generally, people learn through constant exposure to stimuli from the environment (Caine, Caine, McClintic, & Klimek, 2005; McClelland & Rumelhart, 1986). Arguably, according to the connectionist model of learning, teachers who have had repeated exposures to or experiences with BBL practice would know more about these practices than inexperienced teachers.

CHAPTER 2

LITERATURE REVIEW

Introduction

This carefully constructed literature review includes relevant themes, issues, and propositions; it consists of the criteria for selecting the literature, the search for the literature, and the sources from which the materials were drawn. In addition, the history of BBL and the theory surrounding the five variables in the study are discussed. The five variables reviewed included the dependent variable: implementation of BBL practices, and the four independent variables, namely teacher gender, years of teaching experience, knowledge about BBL, and perceptions of BBL. Additionally, this literature review was designed to provide a theoretical basis for the study. The review served as a nexus between previous findings on implementation of BBL and the current conclusions drawn from the study.

Criteria for Selection of Material

The selection of material for this literature review was based on ideals, themes, and propositions of the variables relevant to the study. The ideals included credibility of the sources from which the materials were generated, authors' credentials and neutrality, and the worth of the material. Except for the historical background, the scope of the searches was limited specifically to studies conducted in the United States between the 1970s and 2018. Generally, the articles used were from primary sources.

Aside from limiting articles to primary sources, articles were included based on their focus on the variables used in the study. Based on this, all the hits generated were sorted based on their relevancy to the topic in relation to their consistency with the purpose. Other considerations for selection of the articles included content analysis, authors' credibility, relevancy to the research problem, relationship to the current study, unit of study, the time range, and the domain of the research. The sources were then annotated logically to fit the research purpose and problem.

Finally, a template or table was developed to make sure that the essential elements of the reviewed literature stood out and were formatted, listing the final interpretation of goals, summary, methodology, limitation, date, and unit of study. To guide against ignoring the standard of adequacy, verification was determined to assure that the summary and analysis of the literature was relevant to the topic of study.

The Search for Literature

The search for literature was carefully conducted using Creswell's (2012) five strategies for identifying key terms, which involve identifying key terms, locating items by consulting several types of materials and databases, evaluating and selecting the literature, and organizing the literature.

Important issues that stood out in the literature included ideological discussions on constructivism and connectionism; theoretical issues about neuroscience and cognitive neuroscience (Brunner, 1960; Dewey, 1916, 1996; Galotti, 2014; Snowman, et al., 2009; Webb, et al., 2007); findings about gender (Bowles & McGinn, 2008); pedagogical matters (Duman, 2006; Waters, 2005); historical issues (Ferrari & McBride, 2011; Kahveci & Ay, 2008; Tokuhamma-Espinosa, 2011; Wolfe, 2006); issues about teaching

and learning (Galotti, 2014; Slavin, 2002; Zadina, 2014); neuro-imaging techniques (Aldrich, 2013; Brooks & Brooks, 1993; Gardner, 1983; Marzano, Pickering, & Pollock, 2001; Sousa, 2011; Tokuhamu-Espinosa, 2011); metacognitive factors (Klinek, 2009; Wachob, 2012); issues about change and reforms (George, Hall, & Stiegelbauer, 2006; Hall and Hord, 2011; Hord, Rutherford, Hailing-Austin, & Hall, 1987); implications such as Pygmalion & self-efficacy effects (Brophy, 1983; Brophy & Good, 1974; Cooper, 1979); matters concerning knowledge of BBL (Eisenhart, Behm, & Romagnano, 1991; Galotti, 2014; Goswami, 2004; Griffin, 1989; Harvey, et al., 2002; Jensen, 2005; Klinek, 2009; Sousa, 2011; Wachob 2012); implementation elements (Jensen, 2008; Posner & Rothbart, 2005; Sousa, 2011); learning achievement issues (Galotti, 2014; Marzano, Pickering, & Pollock, 2001; Slavin, 2002; Zadina, 2014); brain function issues (Galotti, 2014; Jensen, 2005; Lyons, 2003; Politano & Paquin, 2000; Zadina, 2014); research-based techniques (Edwards, 2002; Goodlad, 2004, Marks, 2000; McDermott, Mordell, & Stoltzfus, 2001; Roderick & Engel, 2001; Weiss & Pasley, 2004); matters concerning perceptions of BBL (Caine & Caine, 1997; Klinek, 2009; Mansy, 2014; Nash & Norwich, 2010; Pajares, 1992; Wachob, 2012); and matters concerning years of teaching experience (Bedeian, Ferris, & Kacmar, 1992; Crossman & Harris, 2006; Klecker, 1997; Lave & Wenger, 1991; Lutonsky, 2009).

Sources of Material

Articles for this study were garnered from many scholarly databases including JSTOR, ERIC, EBSCOhost, education Extract, ProQuest dissertations and theses, Google Scholar, and others. The algorithm used to generate desired hits was the Boolean. This searching technique led to hyperlink options “Advance Search” where most topics were

retrieved. The hits generated were the result of a title search, others were from wildcard searches, and many more were generated using phrase searches. Like all scholarly works, the types of sources included books, journal articles, and published and unpublished dissertations.

Since the focus of this section was to garner literature for the study, an exhaustive approach was used, making sure the search did not circumvent important elements needed for a comprehensive review of the literature. Thus, key terminologies, phrases, words, and ideas used in the search included BBL; BBL theory; constructivism; curriculum and pedagogy; curriculum implementation; BBL and teacher; BBL and teaching; student, gender and teaching; gender differences and BBL; gender and implementation of curriculum; constructivism and teacher practices; impact of constructivism on teacher practice; connectionism, the connectionist approach of cognition, connectionism and teaching, connectionism and BBL, connectionism and learning, connectionist and teachers' gender, connectionist and teachers' knowledge, connectionist and perception, connectionist and teacher practice; teacher practices and implementation; curriculum implementation; cognition; cognitive psychology and BBL; brain and education; brain and learning; perception and BBL; teachers' perception and curriculum implementation; gender difference and curriculum implementation; gender difference and teaching; gender and teaching; gender and perception and teaching; teaching experience and gender; and teaching experience and curriculum implementation.

More terminology combinations were searched for, including BBL and implementation, perception of BBL, perception and teachers, perception and impact on teaching, perception and self-efficacy, teaching and self-efficacy, teaching and

experience, teacher and experience, experience and curriculum implementation, years of teaching experience and implementation of BBL, teaching experience and performance, emotion and teaching, years of experience and teachers' knowledge, and the brain and learning.

A History of Brain-based Learning

Despite being characterized as a new pedagogical approach, pinpointing the genesis of BBL has not been as straightforward as presumed. Researchers have largely pointed to different sources as the earliest proponents of BBL. While some experts trace its origin to ancient Hellenistic philosophers (Ferrari & McBride, 2011; Tokuhamas-Espinosa, 2011), others have pointed to it as a contemporary concept (Jensen, 2008; Zadina, 2014). For instance, Ferrari and McBride (2011), Tokuhamas-Espinosa (2011), and Sousa (2011) trace the earliest association between the brain and learning to the ancient Greek philosopher, Hippocrates (460-380 BCE), who first described the brain as a source of human sensation, knowledge, and wisdom (Ferrari & McBride, 2011; Tokuhamas-Espinosa, 2011).

Meanwhile, Tokuhamas-Espinosa (2011) also points to the medieval scholar, Al-Haythem (965-1035), as one of the earliest to associate empirical evidence of sensory motor perceptions with the brain. Even those who describe BBL as a modern approach have also characterized it as a gradual evolutionary process that developed slowly over years (Ferrari & McBride, 2011; Kahveci & Ay, 2008; Tokuhamas-Espinosa, 2011). Ferrari and McBride (2011) also found hints of brain, mind, and education or BBL in Leonardo da Vinci's sketches of the brain in 16th century.

Furthermore, Farrari and McBride (2011) identified elements of BBL in Andreas Vesalius's (1543) anatomical work; in the 17th century Christopher Wren's work was cited in Thomas Willis' (1664) Renaissance work, *Anatomy of the Brain*. During this time, John Locke's works (1690, 1693) sought to establish a relationship between virtue, wisdom, breeding, and learning (Aldrich, 1994), setting the stage for Charles Bonnet's *Essay on Psychology* (1755) which further deepened the discourse on the mind, brain, and education. Although the association of the brain with instruction appeared unpopular for many years after the 9th century, it resurfaced among 19th century scholars (Francis Galton, 1869).

In the mid-1900s, Donald Hebb's *The Organization of Behavior* (1949) became another groundbreaking theme for BBL. During this period, BBL became the central theme of the nature versus nurture debate and the most important part of the mind, brain, and education discussion (Tokuhamma-Espinosa, 2011). In fact, during the 19th and 20th centuries, the history of the brain in learning attained another hallmark regarding specific localized domain functions of the brain.

In the 1960s, brain studies, particularly neuroscience, finally gained the recognition of the National Education Association (NEA) (Tokuhamma-Espinosa, 2012), the largest professional organization of teachers in the United States, establishing a BBL research arm (Bransford, Brown, & Cocking, 1999). Confirming this endorsement by the NEA, Aldrich (2013) writes, "At the end of the 20th century, however, developments in neuroscience promised a further and potentially even more important, educational revolution" (p.397).

Computerized axial tomography became the brainchild of Godfrey Hounsfield from a United Kingdom Electromagnetic Interference laboratory in London; a U.S. expert from University of Massachusetts. Later, computerized axial tomography was redefined by Allan Cormack. Next, MRI was invented by Paul Lauterbur (Stony Brook University, NY) and subsequently enhanced by Peter Mansfield (University of Nottingham, UK). Later PET scan and non-invasive fMRI were discovered by Michael Ter-Pogossian, Michael Phelps, and others from Washington University (Sousa, 2011).

Aside from the rapid development of brain-imaging and recording techniques and of neuroscience research institutes, brain and education research gained massive federal support when President George Bush declared the 1990's as the "Decade of the Brain." Such fast-growing brain research turned out to be an inducement for more discrete studies connecting science with pedagogy. Contemporary works on brain and pedagogy include Sousa's exposition on mirror neurons (2011), Roger Sperry's learning styles (1960); and Michael Gazzaniga's concept of split brain (1979). Additionally, there was Madeline Hunter's address on the relevance of science in pedagogy in 1982; and Leslie Hart's publication of *Human Brain and Human Learning* in 1983.

Then in 1983, Howard Gardner released the famous *Frame of Mind: The Theory of Multiple Intelligences*. Additionally, the field has seen L. V. Williams' *Teaching for the Two-sided Mind* (1983), Robert Sylvester's *A Celebration of Neurons* (1995), Caine and Caine's *Making Connections: Teaching and the Human Brain*, (1991), R. N Caine and G. Caine's *Understanding a Brain-based Approach to Learning and Teaching* (1990), and G. Caine's and R.N Caine's *Making Connections: Teaching and the Human Brain* (1994).

The dawn of the 21st century saw another evolution of work including Politano and J. Paquin's *Brain-Based Learning With Class* (2000), Eric Jensen's *Arts with the brain in mind* (2000), Patricia Wolfe's *Brain Matters* (2010), J. F. Callahan, L. H. Clark, and R. D. Kellough's *Teaching in the Middle and Secondary School* (2002), Zull's *The Art of Changing the Brain* (2002), B. Given's *Teaching to the Brain's Natural Learning System* (2002), R.N. Caine and G. Caine's *Brain/Mind Learning Principles* (2005), David Sousa's *How the Brain Learns* (2006), Eric Jensen's *A fresh look at brain-based education* (2008), and Janet Zadina's *Multiple Pathways to the Student's Brain* (2014).

Teacher Practices of Brain-based Learning

Due to the long-held believe that improving teacher practices does increase achievement (Marzano, 2007; Snowman, McCown, & Biehler, 2009; Wenglinsky, 2001), the debate over teacher practice has concentrated on improving instruction and learning (Baratz-Snowden, 2009; Elmore, 1996; McLaughlin & Talbert, 1993). Usually, educational researchers associate quality teacher practices with a pedagogy that enhances learners' cognitive capabilities, an improved learning climate, and classroom organization, and student outcomes (Caine & Caine, 1999; Marzano, 2007; Gunter, Estes, Schwab, 1999; Marzano & Brown, 2009).

Meanwhile, researchers have generally agreed that in order for them to be effective in their practice, teachers must be proficient in learners' cognitive development. BBL experts believe that such teacher foundational knowledge suitable for effective teacher practice should make teachers knowledgeable about how the brain learns (Caine et al., 2005; Jensen, 2000; Politano & Paquin, 2000; Sousa, 2011).

Galotti (2014) has noted that unhealthy teacher practices can overwhelm the learner's cognitive load. According to Galotti (2014), cognitive overload, the "breakdown of the learner's cognitive processing" (p. 408), occurs "when the information available overwhelms the cognitive processing available" (294). Experts believe that BBL practices constitute an appropriate way to avoid such a debilitating route to critical thinking (Driscoll, 2005; Galotti, 2014; Jensen, 2000, 2008; Jensen & Nickelsen, 2008; Robinson, 2017).

Another set of challenges facing teachers is concerned with the fragility and flexibility of cognition. In fact, cognitive neuroscience has identified different neural (brain) networks of attention located in certain regions of the brain and different patterns of event-related capabilities for attended and unattended information (Galotti, 2014). Researchers have shown that selected and divided attention are able to limit the things learners focus attention on at a time (Bressan & Pizzighello, 2008; Fokuda & Vogel, 2011; Spelke, Hirst, & Neisser, 1976). Explaining such selected attention findings, these researchers have concluded that learners process information to which they actively pay attention better than they process unattended information.

Studies (Einstein & McDaniel, 2005; Klein, Robertson, & Delton, 2010; Nairne & Pandeirada, 2010; Peterson & Peterson, 1959) have shown that attended information is held in short-term memory (STM) only for periods up to 20 to 30 seconds, then transferred to long-term memory, the source for retrieval of the information. Furthermore, researching into the modal model of memory has also shown that information is received, processed, and stored differently for each kind of memory (Atkinson & Shiffrin, 1968; Galotti, 2014; Rekart, 2013; Waugh & Norman, 1965).

Additionally, evidence has shown that information held in short-term memory can be hijacked due to a phenomenon described as serial position effect. Experts believe that items or information at the beginning (primacy) or end (recency) of a list of items or a presentation are more easily recalled than are items from the middle of the list” (Galotti, 2014; Murdock 1962, 1965, 1966; Yoo & Kaushanskaya, 2016). Cognitive psychologists refer to the experience in which learners are able to retrieve information at the beginning of a list as primacy effect and those at the end of a list as recency effect.

Teaching according to the way the brain works must embrace instructionally-related cognitive skills that keep students active and focused on a learning task or experience. Researchers are now encouraging teachers to utilize repetition as an effective inducing technique for recalling of stored information (Galotti, 2014; Rekart, 2013). Accordingly, experts are now encouraging teachers to train students in using memory retrieving techniques such as mnemonics and other therapeutic strategies such as chunking, repeated testing, and coding to help learners store and retrieve information from both long- and short-term memories (Ambrose, Bridges, Lovett, Dipietro, & Norman, 2010; Eggen & Kauchak, 2007; Pohlman, 2008; Santrock, 2008). A number of other researchers have advanced theories about visual imagery, spatial cognition, and learning in the classroom spurring applications of visual, auditory, olfactory, kinetic images as mental representations of perceptual experiences and as foundational to learners’ mental experiences (Eggen & Kauchak, 2007; Jensen, 2008; Rekart, 2013).

Cognitive theorists are now emphasizing brain-based teaching approaches that facilitate scaffolding instruction and self-regulated learning. For instance, Snowman, et al. (2009) have advanced psychological concepts applied to teaching, including

communicating clear goals and objectives, stressing organization and meaningfulness, chunking information into a learnable amount within realistic time periods, and promoting encoding of information into long-term memory. Furthermore, Snowman, et al. (2009) encourage instruction to be adapted to the nature and elements of constructivist learning approaches such as providing scaffolded teaching within the Zone of Proximal Distance Development, creating opportunities for learning by discovery and self-directed learning; encouraging multiple viewpoints; emphasizing appropriate problems and tasks; posing problems and tasks in a way that stimulates uncertainty, doubt, and curiosity; and using technology to back cognitive approaches to teaching.

In this context, Caine and Caine (1991) have referred to the teacher as the primary designer of the teaching-learning experience. Ko (2014), a prolific instruction researcher, aptly pointed that “teachers are one of the key elements in any school and effective teaching is one of the key propellers for school improvement” (p.5). For years, BBL experts have maintained that effective teaching must promote experience as the underlying key to all teacher practices (Schon, 1990). Here, Donald Schon insisted that the teacher must display “competence as a core of artistry” (p. 13). Caine and Caine (1991, 2005) have trafficked such notions as orchestrated immersion, implying that instruction should immerse learners in the source information for learning to occur. Cognitive theorists believe that orchestrated immersion is a way to create context and bolster the learners’ schemata (Anderson, Spiro, & Montague, 1984; Emmer, Evertson, & Anderson, 1980).

To bolster such teacher practice, brain-based experts have relied on Vygotsky’s (1978, 2016) conceptualization of cognitive development, which in the mind of Caine

and Caine (1991) helps students to “learn from experience” (p. 104). Contrary to the two-way traditional teaching model where the source of information has remained teacher-to-book or -worksheet, Caine and Caine (1991) supposed that the source of information for a brain-based teaching model must indicate complexity, social interactions, group discovery, individual search and reflection, role playing, and an integrated subject matter. Caine and Caine (1991) observed that these practice elements or elements of orchestration (source of information, classroom organization, classroom management, and outcomes), must be present in order for BBL to be different from traditional teaching.

In fact, BBL experts have incorporated corporate learning strategies and hands-on activities to make the classroom a typical workstation for learners. Brain-based teachers’ adoptions of applied practices for enhancing students’ problem-solving abilities include generate-and-test techniques, means-ends-analysis, working backwards, backtracking, and reasoning by analogy; these strategies have been recommended by cognitive psychologists (Galotti, 2014).

In addition to these strategies, experts believe that a BBL teacher must not operate in a rigidly behavior-controlled teacher-centered classroom, with furniture arranged line-by-line; rather, they should operate in a brain-friendly environment/climate with an appropriate measure of light, an acoustically tuned classroom, a cooperative learning type of seat arrangement, an airy atmosphere, and collaborative teacher-student and peer-peer interactions (Ellis, 2004; Sidelinger & Booth-Betterfield, 2010; Watkins & Wagner, 2000). Wolfe and Brandt (1998) believe that such a learning environment in which the brain operates, to a large degree, determines “the functioning ability of the brain” (p. 8).

In fact, Caine and Caine (1991) argued that what makes a brain-based teaching model different from the traditional teaching model is not the elemental linear, individual-work and teacher-directed classroom organization, but complex, thematic, and integrative workstations, and a cooperative type of classroom arrangement. Consequently, many experts have expanded their understanding of a positive learning or classroom climate to include the notion of a brain-friendly classroom organization and practicing it with graphic organizers, nonlinguistic representations, cooperative learning strategies, cues, questions, technology, language, and music (Borich, 2007; Marzano, 2007; Marzano & Brown, 2009; Marzano, Pickering, & Pollock, 2001).

To be effective, evidence has shown that teacher practice must be embedded in a positive and motivating learning climate. Experts believe that the cognitive development view of motivating students is rooted in Piaget's (1970) philosophies of equilibrium, assimilation, and schema formation. By equilibrium, Piaget was implying that learners have a natural tendency to maintain a sense of organization and balance as they experience changes and growth.

Piaget postulated that such equilibrium is experienced as learners assimilate new experiences in collaboration with an existing scheme or modify a current scheme vis-à-vis a totally new experience (Snowman, et al., 2009). Aware of this inherent motivation to master their environment with a repetitive use of new schemes, teachers will maintain a classroom climate that facilitates activity-based and repetitive engagement with the task on hand as well as scaffolding students to seek answers for themselves.

Despite the extended list for practitioners, experts believe that cognitively a gap exists between the learning and the teaching. To help close the gap, Snowman, et al.,

(2009) have recommended that teachers promote reflective instruction so as to evaluate the extent to which methods and goals are supported scientifically. Caine and Caine (1991) recommend a complex brain-based teaching model that emphasizes reorganization of information in unique fashions, predictable outcomes, and divergent-convergent increases in natural knowledge demonstrated through ability, which incorporates learned skills in variable contexts. Like Caine and Caine (1991), other researchers have shown that implementing BBL practices has always been associated with increasing student achievement (Duman, 2006, 2010; Jensen, 2008).

Teachers' Gender Differences and Implementation of Brain-based Learning Practices

Over the years, concerns have grown regarding the practical implications of the tie between teachers' functional capabilities and their gender on their willingness to implement BBL (Brunning, Schraw, Norby, & Ronning, 2004). Meanwhile, recent breakthroughs in cognitive neuroscience have raised pertinent questions about the role of gender in the implementation of BBL (Wilkins & Gamble, 2013). Such concerns have spurred a flood of scientific inquiries into teachers' gender as a significant determinant of their intent to implement BBL in the classroom. Cahill (2016) acknowledged that such neurological sex differences are receiving increased attention. Gender differences in cognition and brain morphology are well established (Allen, Damasio, Grabowski, Bruss, & Zhang, 2003; Ruigrok et al., 2014).

Accordingly, Laird, et al. (2007) have argued that “understanding how and why men and women teach differently is critical to assisting faculty in their efforts to improve their teaching” (p. 3). To understand the influence of teachers' gender on implementation

of BBL, Hunter (1979) suggests that we focus on what teaching represents. She defines teaching as the process of making and implementing decisions, before, during, and after instruction. Thus, researchers have described such decision-making as a fundamental cognitive process of human beings (Davidson, Cave, & Sellner, 2000; Gurian & Stevens, 2010; Jaušovec & Jaušovec, 2001; Killgore, Oki, & Yurgelun-Todd, 2001; Sax, 2006, Wang, 2007a, 2007b). In investigating the relationship between teachers' functional capabilities and gender, researchers have found that gender does affect the cognitive processes of teachers. Essentially, researchers believe that gender underlies teacher's day-to-day decision-making process.

Associating gender with variations in cognitive skills is consistent with Galotti's (2014) definition of cognitive skill as "sources of individual differences in performance in cognitive tasks, including factors such as intelligence, memory capacities, attention focus, knowledge base, strategies, and processing speed" (p. 409). Eventually, Galotti (2014) has argued that "knowing whether someone is male or female only increases your ability to predict their level of performance by at most 5%" (p. 368). In fact, through brain mapping, neuroscientists have affirmed that differences in the autonomy of the brain are present, in many ways, across genders (Galotti, 2014; Gurian & Stevens, 2010).

After a careful examination of how classrooms are designed, constructed, and operated, Gurian and Stevens (2010) characterized the present discourse about gender-based pedagogy as a reality. However, despite those findings, a growing group of researchers have characterized the debate on gender's role in cognition as inconclusive (Galotti, 2014; Hayes et al., 2004; Taggart, et al., 1997). Galotti (2014), in particular,

observed that “many portrayals of cognitive gender difference falls apart as “either as false or at best greatly exaggerated” upon scrutiny, (p. 373).

In spite of such strong opposing views, Wilkins and Gamble (2013) reported a clear discrepancy in male and female teachers’ penchant for BBL strategies. In fact, most cognitive neuroscientists and educational psychologists have maintained that variations in gender generally carry significant pedagogical undertones (Galotti, 2014, Gurian & Stevens, 2010; Jensen, 2005; Politano & Paquin, 2000). Thus, in concrete ways, experts have affirmed that the way female and male teachers approach elements of instruction can shape their implementation of BBL (Gurian & Stevens, 2010; Klinek, 2009; Wachob, 2012).

On record, several studies (Halpern & LaMay, 2000; Marsh & Yeung, 1998; Wigfield, Battle, Keller, & Eccles, 2002) agree that both men and women can be superior in different disciplines. For instance, researchers have concluded that men score better in quantitative analysis than men; and women score higher in verbal aptitude than men (Jensen, 2005; Galotti, 2014; Gurian & Steven, 2010; Sousa, 2011). Additionally, researchers have shown that a strong correlation exists between teaching style and teachers’ readiness to implement BBL in the classroom. In fact, Lacey, Salah, and Gorman (1998) reported that the styles of male and female teachers vary regarding the way they view student inclusion. Wilkins & Gamble (2013) found that males, rather than females, would be less likely to use interactive learning activities. Starbuck (2003) reported that females, not men, are more likely to conduct group activities.

Within such a backdrop, Grasha (1994) had indicated that women were more likely to use a facilitator or delegator style that emphasizes relating to students as a guide,

consultant, or resource as opposed to transmitting knowledge, setting goals, and providing feedback. In this study, Grasha (1994) also stated that female teachers overwhelmingly favored students' inclusion, although male teachers reported otherwise. In a similar study, Singer (1996) found that "women were more likely than men to invest time planning their courses, designing learning activities, and assessing student learning" (p.673). Accordingly, Laird, et al., (2007) concluded that understanding the relationship between teachers' gender and teaching style can help us understand the kind of practices they implement in the classroom.

Without equivocation, Dweck and others (1978) have concluded that adults who work with children, including teachers, may differ in the patterns of feedback they provide to boys and girls about their intellectual abilities based on the impulse of their expectation. Furthermore, Dweck and his colleagues explained that adults who work with children, including teachers, "might provide different patterns of feedback to boys and girls about their intellectual abilities" (cited in Galotti, 2014, p. 370). Within that backdrop, Measor & Sikes (1992) describe female teachers as more likely to use a facilitator or a delegator style by becoming a guide, a consultant, goal setting, and provision of feedback as opposed to the rigid-knowledge-transmission approach of male teachers.

On the contrary, Measor and Sikes (1992) described female teachers as moderate disciplinarians compared to male teachers. Again, these records seem to portray female teachers as more willing to implement BBL practices than male teachers, since delegating and facilitating styles of instruction fall within the domain of learner-based instruction practices; while rigid knowledge transmission and disciplining styles of instruction fall

outside BBL practices. Due to the notion that BBL thrives well within a less rigid and more teacher-student collaboration atmosphere, Measor and Sikes (1992) suggested the need for male teachers to improve upon their unique gender characteristics in order to make them successful implementers of BBL.

Inarguably, for teachers to motivate their students or create an emotionally stable classroom for students, they must first be able to analyze students' needs of those valuable elements, vis-a-vis their own proficiency and emotional stability. As such, Brophy (1983) postulated that optimally motivating students requires teachers to eliminate impediments to motivation such as a negative attitude, anxiety, and fear of failure (Biehler & Snowman, 1990). On her part, Singer (1996) has affirmed the likelihood of female teachers to utilize motivation instead of punishment more than their male counterparts.

So far, researchers have interpreted these observable teaching styles based on biological differences that impact their cognitive skills (Gurian & Stevens, 2010). Researchers have successfully investigated the role of gender in teachers' ability to facilitate different cognitive skills embroiled in brain education (Galotti, 2014; Gurian & Stevens, 2010). For instance, based on established variations in the inferior parietal lobe, cognitive experts have explained boys' advantage over girls in spatial and mathematical reasoning skills (Galotti, 2014; Raz et al., 2004).

Fundamentally, experts believe that the male brain is 10 to 15% larger and heavier than the female brain (Wanjek, 2002; Zeenat & Zaidi, 2010). However, dismissing these anatomical differences as mere myths, Wanjek (2002) described such differences in brain size as minor variations that do not significantly affect learning or behavior. Like Wanjek

(2002), Davison (2012) argues that brain size has little relationship to intelligence. Yet, depending on what is being addressed, gray or white matter, these differences in brain size seem to offer varied advantages to men and women. Experts have found that men, on average, possess six times more the amount of gray matter related to general intelligence than women, while women have nearly ten times the amount of white matter related to intelligence than do men (Raz, et al., 2004; Sowell et al., 2007).

It is crucial that teachers learn to adapt to these differences to more effectively communicate the subject material. Despite the argument against brain size and learning, Gurian & Stevens (2010) encourage teachers to be aware that the brain structure differences have a significant effect on learning. Inarguably, knowing their own weaknesses will help teachers to implement better teaching strategies to help students succeed in their education.

Furthermore, researchers have reported distinct gender differences in the way male and female cognitive processes operate. For instance, Galloti (2014) posited that, on average, males hold a visual advantage in working with lists and in making deductive decisions. In view of all these reports, Kuh, Nelson-Laird, & Umbach (2004) put it, “women are more likely than their counterparts to value and use effective educational practices, such as placing an emphasis on academic challenge and enriching educational experiences” (p. 29). While it remains imperative not to assume female teachers are teaching better than male teachers, we can argue that female teachers are better placed to implement BBL practices than male teachers, given the advantages they appear to have over male teachers. Aware of the benefits of visual aids in learning, deductive reasoning, and interactive learning, Gurian & Stevens (2010) encouraged male and female teachers

learn to deal with such barriers, in order to equip them well them to effectively implementing BBL in the classroom.

In part, researchers have credited the variations in male and female teachers' process of cognition to differences in men, arguing that men are more left-brained (logical, objective) while women more right-brained (intuitive, creative, and emotional) (Williams, 1983). Generally, researchers believe that the corpus callosum, the most prominent white matter structure, is responsible for integrating the activities of the left and right cerebral hemispheres.

Through MRI, different studies have included in such integration of the left and right cerebral hemispheres the harmonization of sensory areas (Berlucchi, 1981; Galotti, 2014), the storage and retrieval of memory storage (Putnam, Wig, Grafton, Kelley, & Gazzaniga, 2008; Zaidel & Sperry, 1974), the allocation of attention and arousal (Giedd et al., 1994; Giedd et al., 1996; Levy, 1985; Levy & Heller, 1992). In fMRI activation data for men and women showing both anterior and posterior temporal lobe activation at the corpus callosum, Gurian & Stevens (2004) confirmed that “men demonstrated markedly asymmetric activation, whereas women tended to show more symmetric temporal lobe activation” (p. 13). For instance, regarding left-brained logical or objective reasoning such as problem solving and quantitative reasoning, the record shows males outperforming females (Alekn, 2012; Barnes, 2017; Benbow & Stanley, 1980; Bonomo, 2012; Hyde, 1981; Maccoby & Jacklin, 1974).

Generally, experts credit the differences to the fact that key sections of the corpus callosum in average female brains are slightly thicker and larger than in average male brains (Achiron, Lipitz & Achiron, 2001; Dubb, Gur, Avants, & Gee, 2003; Gurian &

Stevens, 2004; Smith, 2005). Here too, experts have credited such differences to explain why women exhibit advantages on some cognitive skills in contrast to men and vice versa (Gur, et al., 2000; Shaywitz et al., 1995). Hence, BBL experts have believed that differences in the size and function of male and female teachers' corpus callosum can have significant effects on their implementation of BBL, particularly on their verbal and qualitative acuties, multi-tasking and logical functional capabilities, creativity and emotional wellness, attention levels, self-awareness, self-motivation, and self-management levels (Erlauer, 2003; Jensen, 1995, 2000; Wolfe, 2001).

In addition to having a larger and thicker corpus callosum, authors have credited women with superior language skills (Gabriel & Schmitz, 2007; Gauthier, Duyme, Zanca, & Capron, 2009; Ruytjens, Albers, van Dijk, Wit, & Willemsen, 2007). Through use of the MRI, researchers have indicated that, on average, Broca's areas of female brains are significantly larger than Broca's area in male brains (Harasty, Double, Halliday, Kril, & McRitchie, 1997). In fact, (Wachob, 2012) has confirmed that female teachers report implementation of more BBL practices than male teachers.

Another explanation for differences in teachers' performance and practice is how male and female teachers deal with emotions. Generally, experts believe that a correlation exists between emotion and learning environment as well as emotion and instruction (Greenleaf, 2002, Snowman, et al., 2009; Sousa, 2011). Thus, BBL experts tend to associate the release of endorphins with a positive learning environment that optimizes healthy student emotions (Jensen, 2005; Politano & Paquin, 2000, Sprenger, 2002). Endorphins, according to scholars, are responsible for stimulating pleasurable feelings in

the frontal lobe, the site of the brain responsible for executive actions (Erlauer, 2003, Sousa 2011).

Contrariwise, experts have found that a stressful learning environment can stir a discharge of cortisol into the brain (Sousa, 2006). Meanwhile, a higher cortisol level saps an individual's energy, leading to errors, distraction, and forgetfulness, consequently frustrating performance (Connell, 2005). By contrast, experts believe that amygdalae volume (and the presence of excess testosterone) offers explanation of why stress has a positive effect on learning in males, but inhibits learning in females (Sax, 2006; Shors & Miesegaes, 2002; Wood & Shors, 1998). Although, on record, gender differences in amygdala volume starts in early childhood, during puberty, males' amygdala volume accelerates faster than females (Jaušovec & Jaušovec, 2001; Jaušovec, Jaušovec & Gerli, 2001).

Furthermore, researchers have successfully investigated the role of the prefrontal cortex in the planning of movement, making decision, implementing strategies, inhibiting inappropriate behaviors, and using working memory to process information (Galotti, 2014). The prefrontal area, which is right behind our forehead, deals with emotions, personality, working memory, attention, and learning (Galotti, 2014, Sprenger, 2002). Gurian and Stevens (2004) found that the growth of the prefrontal cortex proceeds differently for males and females. It has been reasoned that the lesser ability of the prefrontal cortex to overrule the emotionally excitable amygdala could explain the tendency for males to generally take greater physical risks, be more impulsive, and exhibit less emotional intelligence than females (Killgore, et al., 2001).

Hence, experts have explained why, from the onset, females are able to handle boredom better and display greater emotional intelligence than males because of an earlier development of their prefrontal cortices (Davidson, Cave & Sellner, 2000; Jaušovec & Jaušovec, 2001; Killgore, et al., 2001; Sax, 2006). Consequently, BBL experts have recommended that teachers acknowledge the delicate interplay between their own gender, cognitive abilities, teaching styles, and implementation of BBL practices (Jensen, 2008; Sousa, 2011).

Teachers' Knowledge and the Implementation of Brain-based Learning Practices

Teachers' knowledge about BBL remains scant, in spite of its immediate successes in many schools that have tried it (Goswami, 2004; Jensen, 2005). Studies (Klinek, 2009; Wachob, 2012) have shown that the majority of teachers accept the fact that they lack knowledge of how the brain learns and that they may benefit from professional development training on the topic of the brain and learning.

In Wachob (2012), the analysis of 256 K-12 public-school teachers aimed at ascertaining whether teachers' knowledge impacted their knowledge, beliefs, and implementation of BBL (if any patterns existed between) found that 75.4% of teachers indicated willingness to initiate BBL if they knew more about it; 75.4% of teachers were willing to change their current style of teaching. Anticipating that such apparent lack of knowledge may limit overall teachers' implementation of BBL in classrooms, Wachob (2012) suggested there is a need to equip teachers with knowledge of how to implement BBL.

Generally, teacher knowledge has been deemed central for effective teaching (Jensen, 2005); however, because of inadequate attention among policy makers, school leaders, educators, and teacher educators, and because they have paid particular attention to the critics of BBL, most classroom teachers still lack the prerequisite knowledge needed for actual practice. In describing this predicament, Danielson (2007) argues strongly, “without proper knowledge teachers can find the complexities of teaching rather unnerving and repugnant” (p. 170). Sousa (2011) also argues that knowledge of brain-compatible instruction is essential for educators because, fundamentally, teaching and learning demands knowledge of how the brain acquires, processes, and constructs information. In view of such overwhelming evidence backing the concept of BBL, Jensen (2005) has suggested that teachers should be experts on the brain and be trained as such.

To ensure an adequate response requires closing the ever-widening gap between research and practitioners, particularly teachers, as well as between teacher education programs and actual classrooms. The knowledge in question, according to Sousa (2011), should include content or subject-matter knowledge, pedagogical knowledge, and teaching skills. Pedagogical knowledge represents the applied knowledge to implement a particular method, and teaching skill requires the knowledge needed to execute a discrete skill, say intergroup cooperative learning. In fact, BBL has been classified as a holistic approach embodying all three knowledge categories (Sousa, 2011).

Generally, researchers see a close relationship between the knowledge that teachers have about a curricular product and anxiety. As a whole, insufficient teacher knowledge has always carried many field implications, including burnout and turnover among teachers (Eisenhart, et al., 1991; Griffin, 1989; Seferoğlu, 2004). While

implementation in general is difficult, implementing a curriculum product of which teachers lack significant knowledge can be emotionally challenging. Hence, BBL scholars are now urging reforms in teacher education and professional development aimed at reducing teacher anxiety (Murray-Harvey, et al., 2000), by addressing novel concepts such as BBL, which would bolster teacher confidence prior to their tenure review (Klinek, 2009).

The discussion regarding the foundational knowledge requisite for the implementation of BBL has drawn strong criticism from certain cognitive psychologists. Bruer (1997) in particular has discounted the knowledge supposedly needed by teachers to implement BBL as unnecessary, irrelevant, and oversimplified, arguing that brain science remains unready to serve as the basis for pedagogical practice. In 1997, Bruer insisted that because neurological studies at that time (e.g., synaptogenesis, synaptic pruning, sensory motor development, and the impact of the environment on synaptic formation) were conducted primarily on cats and monkeys instead of humans, they cannot inform classroom teaching.

As such, Bruer (1997) maintains that although neuroscience has discovered a great deal of information about neurons and synapses, “it is still not enough to guide educational practices” involving humans (p. 4). Although Bruer’s critique highlights salient issues that should be addressed, particularly regarding the practical implications from neurophysiology, he may overlook some relevant neurologically related propositions from BBL theory, including the presumed salience of attention, memory, information retrieval, visual imaging, sleep, emotion, activities, and reasoning for the teaching-learning process (Jensen, 2005; Lyons, 2003; Politano & Paquin, 2000).

This issue of knowledge inadequacy relevant to BBL among teachers may be used to measure the quality and effectiveness of teacher education programs. Thus, one way to gauge the value of teacher education programs is to assess the effectiveness of teachers in the classroom. In a survey that asked school principals to identify the five most common factors associated with teacher ineffectiveness, classroom management skills ranked the highest, among an average of 242 principals. According to the outcomes of the survey, lesson implementation skills ranked second, third on the list was rapport with students, lesson planning ranked fourth; the last but not least was deficiency in subject matter knowledge, which ranked fifth (Snowman, et al., 2009); all of these are indicators of BBL.

According to Galotti (2014), “understanding how and under what circumstance people mentally represent information is critical in exploring how they carry out a variety of cognitive tasks” (p. 205). Galotti’s observation aligns well with Wachob’s (2012) argument that, as an effective teaching strategy, BBL not only induces confidence in teachers, but improves the overall school climate. The most important change for education, Caine and Caine (2005) observe, resides in the understanding of how human beings learn and placing that understanding in the center of teaching.

Undoubtedly, the question that should be asked is not whether enough theory has been generated to substantiate a curriculum reform, but whether current discoveries can be used to fine-tune teaching and learning. The answer lies in the massive call by experts for teacher educators to strike a balance between the academic theory they offer and the actual classroom realities that teachers face. Sylvester (1995) argues that with knowledge

of BBL, growing teachers should be aware of new advancements in order to improve their instructional delivery methods.

Implementation of BBL should not wait for a complete understanding of brain science, because this broad area of investigation develops incrementally. Although teachers should not and cannot master neurology or similar disciplines before they begin applying significant findings to their work, areas of brain research that are well understood can be applied while investigation of the unknown areas continues.

Teachers' Perceptions and the Implementation of Brain-based Learning Practices

Despite the much-acknowledged influence teachers' perception of BBL has on their work, individual teacher perceptions of it have remained fragmented. This fragmentation has been explained by the fact that, fundamentally people see reality differently (Pajares, 1992). In fact, Pajares asserted that the way teachers view reality can shape the way they think about education and teaching. Sternberg (2009) has defined perception as "the process by which we recognize, organize, and make sense of the sensations we received from environmental stimulus" (p. 75). Such a habitual way of making sense of reality may underlie the fragmentation in an individual teacher's perception of BBL.

Caine and Caine (1977) have argued that "because people have different perceptual orientations, some educators are more at home in the world of change and turbulence than others" (p.11). In fact, experts agree that perception resides at the heart of human behaviors, beliefs, decisions, and actions (Caine & Caine, 1997; Sternberg, 2009).

Thus, researchers apply the term perception to represent the way teachers view and make sense of the world.

Accordingly, researchers believe that teachers' perceptions of BBL are grounded in the beliefs about what a person is already doing (Klinek, 2009, Mansy, 2014; Siercks, 2012; Wachob, 2012). Based on that assumption, Caine and Caine (1997) affirm that teachers' perceptions of BBL, as an instructional approach, is grounded in the way educators view reality (p. 11). Furthermore, based on this assertion, Caine and Caine (1997) argued strongly that teachers' specific outlook on reality, including their appreciation for all the nuances and implication of reality, constitutes a necessary impetus for their implementation of BBL.

Investigating teachers' perception of BBL has been grounded in decades of research (Caine & Caine, 1997; Denton, 2010; Klinek, 2009; Mansy, 2014; Siercks, 2012; Wachob, 2012). Over the years, experts have investigated the formation of a teacher's perception, tracing it to the early part of the teacher's own school days during which the beginning teacher embraced the practices of experienced teachers in the field (Kagan, 1992; Lortie, 1975; Stuart & Thurlow, 2000). Lortie (1975) referred to such learning from experienced teachers as apprentice observation. The initial perception of the novice teacher, according to Nespor (1987), grows stronger in time with vivid emotional and personal experiences.

Aside from its roots in years of apprenticeship, experts have traced the fragmentation of teachers' perception of BBL to teachers' view of BBL as a learner-centered, constructivist instructional approach (Caine & Caine, 1997, 2005; Jensen, 2005; Sousa, 2011). Although experts have successfully shown the importance of learner-

centered constructivist instruction in improving student learning (Harkness, 2016; Kubaisi, 2011; Ahmed & Qarareh, 2016; Saadi, 2010; Turner, 2012), teachers have shown a stronger penchant for teacher-centeredness instead (Goodlad, 2004; McDermott, et al., 2001).

Traditionally, within a typical teacher-centered classroom, teachers view themselves as primary transmitters of knowledge and the learner as a recipient of information from the teacher (Adair-Hauck & Donato, 1994). Due to this, most teachers perceive learner-centeredness as a tedious and counterproductive teaching approach that depresses their voice (Bayat, 2012). In fact, researchers believe that such false perceptions can undermine teachers' confidence to implement BBL (Klinek, 2009, Mansy, 2014; Wachob, 2012). In separate studies, Klinek (2009) and Wachob (2012) confirmed that such unbalanced perceptions, if not corrected, can impede teachers' readiness to implement BBL practices in the classroom.

Experts believe that such negative perceptions can lead to a feeling of inadequacy and a lack of confidence that ultimately affect teachers' courage to implement BBL practices (Denton, 2010; Klinek, 2009, Mansy, 2014; Siercks, 2012; Wachob, 2012). Thus, Jensen (1995) has avowed that the unique nature of cognitive diversity within a typical classroom can undermine the perceptions of teachers. Generally, experts have shown that change can be effective only when it is personal for the change agent (Fuller, 1969; George, et al., 2006).

Addressing the need for real change in teachers' perceptions of BBL, Caine and Caine (1997) affirm that "the key to successfully transform education lies in transforming ourselves" (p. 11). In *Making Connections: Teaching and the Human Brain*, Caine and

Caine (1991, 1994) acknowledged that such changes in individual teachers' perceptions can be a potential learning experience for teachers. In this context, Caine and Caine (1994) noted, "Every complex event embeds information in the brain and links what is being learned to the rest of the learner's experiences, past knowledge, and future behavior" (p.5). Evidently, any skewed perceptions teachers may have about BBL practices tend to embed information in teachers' brains and creates links to their future readiness to implement it.

Typically, a developing teacher's negative perception of a new instructional approach such as BBL may collide with the teacher's perception of existing approaches. Thus, inasmuch as BBL practices may appear to teachers as a new worldview, or an innovation, or a new environment; fundamentally, they will have to embrace new worldview in order to overcome their apathetic perception for such a new environment or overcome their entrenched experience with previous practices (Caine & Caine, 1997). The term worldview in this sense represents a framework within which teachers think and perceive their work, as well as sets limits on a particular teaching approach such as perceptual orientation (Caine & Caine, 1997).

In a study that examined how the transformation of teachers' perception of BBL works, Caine & Caine, (1997) observed three different instructional approaches: the traditional teacher-centered or stand-and-deliver command model, the control model, and the non-traditional organic and dynamic model. Instructional Approach One (traditional teacher-centeredness) or stand-and-deliver model focuses primarily on student acquisition of prescribed factual and conceptual knowledge acquired through memorization, rehearsal, and repetition practices.

By contrast, Instructional Approach Two, the more meaning and depth-based instructional approach, focuses on exploration as well as expounding more conceptual knowledge. Although both approaches One and Two involve some form of memorization, Approach Two is more learner-centered than Approach One. Instructional Approach Three, the most learner-centered of all the three, was “underlined by the constructivist assumption that views learning as naturally organic, dynamic, fluid, and open; and which assumes that school curriculum and teaching must be based on the learner. Basically, Caine and Caine (1997) envisaged this approach as BBL.

Furthermore, the study found that Instructional Approach Three allowed the learner to “focus individually or gather collectively around critical ideas, meaningful questions, and purposeful projects” (Caine & Caine, 1997, p. 25). Next, Caine and Caine compared the three instructional approaches with three basic orientations of perception, that is, transmission, transactional, and transformation orientations. Caine and Caine (1997) characterized the three perceptual orientations or worldviews as the essential pathways on which education thrives.

The first perceptual orientation, transmission, represented what teachers do when they conceive the universe in small irreducible units. The second perceptual orientation, transaction, stood for what teachers engage in when the universe is seen as rational and intelligible. And the third perceptual orientation, transformation, represented what teachers engage in when they see the big picture, including the relationship between the various irreducible units and can make sense of the single universe they represent.

Eventually, Caine and Caine (1997) found that the transformation orientation aligned with the perceptual orientations that underlie teachers’ adoption of Instructional

Approach Three which symbolizes implementation of BBL. Caine and Caine (1977) found that teachers at Perceptual Orientation One cannot fathom Instructional Approach One. However, those at Perceptual Orientation Two cannot think about or do both Instructional Approaches One and Two. Only those at Perceptual Orientation Three can think in sufficiently fluid and integrated ways to embrace all three instructional approaches. From this experiment, it was concluded that teachers who adopt BBL as their instructional approach are able to embrace other teacher-centeredness as well as well as other transitional approaches. Hence, Caine and Caine (1997) resolved that successful transformation of a teachers' perception can bolster their willingness to implement BBL in the classroom. In conclusion, Caine and Caine (1997) recommended the reconfiguration of the educational system to suit Perceptual Orientation Three.

This conclusion has received broad support from the research community (Denton, 2010; Klinek, 2009; Mansy, 2014; Siercks, 2012; Wachob, 2012). For instance, Caine and Caine's conclusions corroborated Denton's (2010) argument that teachers are likely to adopt more effective teaching methods when they have a conscious awareness of the impact that their beliefs have on learning.

In accordance with the Theory of Planned Behavior which postulates that a person's beliefs affect their plans for behavior, which sequentially influence their visible actions, researchers have argued that, like beliefs, perceptions do exercise grave impact on teacher behavior (Ajzen, 1991; Giorgi, Roberts, Estep, Conner, & Stripling, 2013). Indisputably, realigning the educational system and teachers' roles can help improve teachers' perception of BBL.

Webb, et al. (2007) identified school administrators' failure to serve as direct advocates against external intrusions as counterproductive to improving teachers' perception of instructional approaches. Accordingly, BBL experts have shown that equipping teachers with the necessary tools will positively impact their perception for BBL practices (Caine and Caine, 1994, 1997; Denton, 2010; Jensen, 2005).

With respect for Adair-Hauck & Donato's (1994) finding that teachers perceive themselves as the primary transmitters of knowledge, Fullan (2001, 2008) suggested that teachers must be given a certain level of autonomy for them to function as presumably they should. Unfortunately, in recent years, due to state accountability, content standards, and assessment programs the level of autonomy that teachers had before has declined (Webb, et al., 2007).

To help teachers develop a positive worldview or perception of BBL practices, Jensen (2005) also recommended that school administrators promote quality professional development, a motivating curriculum, as well as time and structure for collegial sharing and support. Aside from Jensen (2005), the Heschong Mahone Group (2003) has suggested that school administrators assign teachers to classrooms suitably designed for brain-based instruction. According to the Heschong Mahone Group (2003), a classroom designed for brain-based instruction should have sufficient light, be acoustically designed, foster teacher-learner interaction, and make student movement easy. Generally, scholars agree that a strong positive correlation exists between teachers' perceptions and a well-managed classroom (Ahmad, Rauf, Rashid, & Ali, 2012; Ellis, 2018; Zoromski, 2016).

The Impact of Teachers' Gender on their Perceptions of Brain-based Learning

The rapid advancements in neuroscience research have produced new insights that have the potential to elevate our current understanding of the influence of gender in teachers' perception of BBL. In recent years, experts have found that humans have special neurons in the inferior frontal gyrus and inferior parietal cortex that react to the actions of other individual (Christov-Moore, et al., 2014; Cooper, 2004; Halpern, et al., 2011; Halpern, Straight, & Stephenson, 2011). Scientists have nicknamed them mirror neurons because of their capability to enable to mirror or mimic another person's activities. For instance, Zadina (2014) found that "mirror neurons become more active when engaging with people more similar to us" (p. 199).

Generally, neuroscientists refer to mirror neurons as the gender imitation-bias (Losin, Depretto, & Iacoboni, 2009; Losin, Iacoboni, Martin, & Dapretto, 2012). From their findings, these experts have argued that we mirror people of the same gender because watching a person of the same gender can stimulate the brain's reward pathway. Evidently, the presence of mirror neurons tends to highlight the importance of modeling or apprenticeship modeling incorporated into our pedagogy on many levels.

Although much still remains unknown about mirror neurons, the research surrounding such mimicking qualities has also enabled us to decipher the way male and female teachers' behaviors, intentions, and ability work pertaining to the implementation of BBL (Jennings & Greenberg, 2009). For instance, the discovery of mirror neurons has highlighted the significance of modeling or apprenticeship modeling and empathy incorporated into our pedagogy on many levels. In fact, some studies have portrayed

females as more nurturing and empathetic, while at the same time depicting males as more cognitive than emotional (Christov-Moore, 2015; Halpern, et al., 2011).

As the research on issues of empathy and emotion collided with new findings on motivation it became apparent that motivation remains the key element that drives the empathy that people express for others (Klein & Hodges, 2001). According to Christov-Moore and his associates (2014), the findings about motivation and empathy/perception reflects the lack of teacher awareness concerning the profound nature of gender stereotypes and their overall influences in the classroom.

On the whole, the investigation of mirror neurons appears to suggest that women, and for that matter, female teachers, are more perceptive than men. Yet, studies (Pinar, Blumenfield-Jones, & Slattery, 2008; Darling-Hammond & Bransford, 2005) have indicated that most female teachers work within a masculine hegemonic environment. Neuroscientists and social psychologists investigating perception and interpretation of social settings and the neural foundation for prejudice and stereotyping have concluded that mental processing depends largely on cognitive brain mechanisms devoted to social reasoning (Alexander, DeLong, & Strick, 1986; Cikara, Eberhardt, & Fiske, 2011; Olsson, Ebert, Benaji & Phelps, 2005; Overwalle & Baetens, 2009). Such apparent agreement between cognitive psychologists and neuroscientists has tended to fuel the belief in apparent differences between female and male teachers (Gilbert and Malone, 1995; Trope and Gaunt, 2000; Van Rooy & Viswesvaran, 2004).

Years of Teaching Experience and Implementation of Brain-based Learning Practices

While years of teaching have been the focus of considerable research in recent decades, little research has been conducted on its relationship with teachers' disposition toward BBL. Researchers have had a divergent view about the complex role that years of teaching experience play in teachers' willingness to implement BBL practices in their classroom. Some studies indicated a negative relationship between years of teaching experience and teachers' implementation of BBL experiences (Klinek, 2009; Mansy, 2014; Wachob, 2102).

By contrast, some other researchers have suggested a positive relationship between years of experience and implementation of BBL experiences (Galotti, 2014; Morris, 2010; Zadina, 2014). On the one hand, some experts associate the construct—years of teaching experience—with the tenure or number of years of teaching a teacher has rendered after his/her years of college (Bedeian et al., 1992; Crossman & Harris, 2006; Klecker, 1997). On the other hand, professional development experts regard years of teaching as a lifelong experience for teachers (Darling-Hammond & McLaughlin, 1995; Gray, 2001; Shibley, 2001; Torrance, 2001; U.S. Department of Education, 2000).

Understanding teaching as a developmental process or lifelong experience is rooted in the mindset that professionally, teaching involves a continuous learning experience (Archer, Hoff, & Manzo, 2001; Darling-Hammond, 1997, 2006; Senge et al.; 2000; Wasley, Hampel, & Clark, 1997). Thus, based on this conception of teaching as a lifelong learning experience, professional development experts have promoted reforms that shift the teacher's role from a disseminator of knowledge to that of a continuous learner (Darling-Hammond, 1997; Darling-Hammond & McLaughlin, 1995).

In this study, the construct—years of teaching experience, is synonymous with tenure or number of years of teaching. From that standpoint, this study operates under the assumption that having a better perspective of the relationship between years of teaching experience and teachers' disposition toward BBL can be useful data for closing the gap in the existing literature. This is based on this premise that understanding the relationship between teachers' disposition to BBL and their years of experience could serve as added impetus for researchers, educators, and policy-makers to promote BBL.

Such breakthroughs in understanding can be a counteractive tool for the apathy and lackluster attitudes among teachers, thus helping K-12 stakeholders to better facilitate the implementation of BBL. According to some experts (Brinkley, et al., 1999; Lave & Wenger, 1991), the effectiveness of career development largely hinges on critical reflection of everyday professional practice. Undoubtedly, understanding teachers' willingness to try BBL from the perspective of their years of experience could motivate teachers to implement BBL in their classrooms.

For experts, the assumption underlying the concept that views teaching as a lifelong experience posits that the effectiveness of career development depends on critical reflection as an everyday professional practice (Brinkley, 1999; Lave & Wenger, 1991). In fact, Dewey (1916, 1996) suggested that being the primary facilitators of change, teachers must possess the ability to self-regulate their learning experience by reflecting over their years of teaching experience vis-à-vis the effectiveness of the approaches they have adopted. In Dewey's mind, experience becomes the end product of such repetitive reflection.

Like Dewey, many experts have affirmed that teachers' self-examination ability can guarantee a growing positive disposition that translates into confidence, self-efficacy, and satisfaction with their professional practice (Brinkley, 1999; Charles & Mertler, 2010; Crossman & Harris, 2006; Koustelios, 2001). In fact, Morris (2010) attributed teachers' higher use of brain-based strategies in the classroom to the greater satisfaction they get from using it. This finding by Morris (2010) is consistent with other conclusions that satisfaction attained through years of professional practice becomes the impetus for teachers to implement BBL in their classrooms (Long & Swortzel, 2007; Ridley, 2012; Winter, 2015). Hence, Baek, Jong, and Kim (2008) argue that teachers who are more experienced demonstrate more readiness to integrate innovation into their practice.

In a different way, Inan and Lowther (2010) affirm Baek, Jong, and Kim (2008), after they found that the more years of teaching experience increase, the less he/she is ready to implement technology-based innovation in the classroom. However, in the interim, Woolfolk (2001) characterizes integration of technology as a constructivist approach "grounded in the research of Piaget, Vygotsky, the Gestalt psychologists, Bartlett, and Bruner as well as the educational philosophy of John Dewey" (p. 329) all of whom have embraced BBL. It can be inferred that more years of teaching experience influences the readiness of the teacher to implement BBL practices.

Generally, experts believe that implementing a school change requires teachers to be highly skilled as well as have self-confidence (Darling-Hammond, 1997; Marzano, 1992). In her study, Ertmer (2005) depicted self-confidence as the fundamental determinant of teachers' self-efficacy. Ross, Cousins, and Gadalla (1996) also found a positive correlation between teacher experience and a higher level of self-efficacy.

Reconciling these recoveries, Ertmer & Ottenbreit-Leftwich (2010) described the lack of self-efficacy as a potential barrier facing teachers regarding their implementation of school innovations.

In fact, within the teacher workforce, self-efficacy is defined as teachers' own belief in their ability to organize and carry out activities needed to reach educational goals (Skaalvik & Skaalvik, 2010). Wolters & Daugherty (2007) have acknowledged that more experienced teachers are likely to feel more adept in their classroom practice. Such an association between heightened teacher proficiency and years of teaching experience has been corroborated by recent BBL experts (Galotti, 2014; Morris, 2010; Zadina, 2014).

Ahead of these contemporary findings, Fuller (1969) had grouped teachers, based on their years of teaching experience, into educational students, beginning teachers, and experienced teachers. After examining the differences in the use of brain-based strategies and years of teaching experience, Morris (2010) found that teachers with fewer (0-10) years of experience used fewer of the surveyed brain-based practices than teachers with more experience (21-31+ years). Morris attributed the higher use of brain-based strategies in the classroom to greater teacher comfort and knowledge level. Ultimately, Morris (2010) attributed the higher adoption of brain-based strategies in the classroom by more experienced teachers to greater satisfaction and knowledge level accumulated over years teaching. That seems to have negatively impacted the general trend in which teachers with greater years of experience have always been more likely to utilize BBL processes than those with less years of teaching experience.

Furthermore, the latest findings about the concept of neural plasticity shed light on the significance of years of teaching experience on the implementation of BBL practices (Galotti, 2014; Zadina, 2014). When it comes to neural plasticity, researchers put experience or development and learning at par, arguing that experience leads to learning. Hebb (1949) was the first to establish a theoretical framework that defined neural plasticity as the brain's ability to adapt to its environment based on experience and development (Casey, Amso, & Davidson, 2006; Galva'n, 2010). Galva'n's exploration of whether development and learning are related showed that the two constructs are inseparable. Galva'n hypothesized that "repetitive stimulation of synapses can cause long-term potentiation or long-term depression of neurotransmission" (p. 881).

Furthermore, she noted that such "changes should be associated with physical changes in dendritic spines and neuronal circuits that eventually influence behavior" (p. 881). In Galva'n's study, the resultant influence on behavior from changes in neural plasticity can be described as learning. Experts have argued that the more ways something is learned or experienced, the more memory pathways are built (Craig, 2003; Galotti, 2014; Goswami, 2004; Jensen, 2008). Like Galva'n (2010), other BBL experts define experience and learning as a change in the brain. For instance, Zadina (2014) defines the term plasticity as "the brain changes as a result of experience" (p. 11). She affirmed that learning occurs when people gain experience or repeatedly practice activities controlled by parts of their visual, motor, sensory, or coordination systems learning occurs.

To summarize, Galotti, (2014) has maintained that such structural and functional changes in the brain can be the result of training, learning, physiological changes, and

experience. Morris (2010) noted that experience constitutes a likely determinant of the frequency with which teachers implement BBL practices in their classroom. In fact, Galotti insisted that the more experience teachers have, the more comfortable they become in adopting BBL.

To conclude, this literature provided conclusions about those works that make the greatest contribution to the understanding and development of the main subject of the study. Summaries and analyses of themes identified critical issues relating to the area of study to meet the aims outlined in the introductory chapter.

CHAPTER 3

METHODOLOGY

Introduction

Primarily, this study focused on the 3.1 million public-school teachers in the K-12 system in the United States. In the 2017-2018 school year, the National Education Association (NEA, 2018) estimated the K–12 classroom teacher population within the public school system to be 3,126,790.

The purpose of this paper was to determine how public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL related to their willingness to implement BBL practices in the classroom. This section of the study describes the methodology, defines the type of research or research design, the population and the sample, the hypothesis, and the definition of variables. Additionally, the section describes instrumentation, data collection, and data analysis.

Research Type

This study can be characterized as non-experimental quantitative research study with a correlational design. The non-experimental quantitative research study was conducted to address the question: how do public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL predict their willingness to implement BBL practices in K-12 classrooms? Although quantitative

research methods, experimental and non-experimental, involve the gathering and analyzing of objective data, unlike quantitative experimental research, a non-experimental quantitative study does not require direct manipulation of the independent variables; rather the variables are studied as they exist (Creswell, 2012; McMillan & Schumacher, 2010).

Given the non-experimental quantitative nature of this design and its primary investigatory focus on relationships among variables as well as the numeric size and continuous nature of the variables, a parametric design such as correlational research design remained the better design option. A correlational design, according to McMillan & Schumacher (2010) "permits the simultaneous study of several variables" (p. 226). Unquestionably, a correlational research design has the advantage of measuring the degree of association or relationship among the variables instead of manipulating them.

A correlational study design, according to Creswell (2012), constitutes a non-experimental quantitative paradigm that uses correlational statistics "to describe and measure the relationship between two or more variables or set of scores" (p. 338). Furthermore, Creswell (2012) posits, "Correlation researchers use the correlation statistics to predict future scores. To see what impact multiple variables have on an outcome, researchers use regression analysis" (p. 349). Hence, Multiple Linear Regression (MLR) was adopted as the most robust correlational statistical method and used to measure the combined and independent relationships the four predictors in this study (gender, years of teaching experience, knowledge about BBL, and perception of BBL) have with the criterion (implementation of BBL practices).

Internal Validity of Design

In this study, internal validity was construed as the degree to which the design of a study backs the conclusion that changes in the independent variables correspond to observed variations in the dependent variables. In fact, Creswell (2012) has defined internal validity as “the validity of inferences drawn about the cause-and-effect relationship between the independent and dependent variables” (p. 303). For a study’s outcome to be flawless and reliable, Creswell (2012) insists that researchers consider the various threats to the study’s validity and reliability.

This study was designed to generate credible quantitative inferences about the unobserved population of public K-12 teachers outside the registered internet community while simultaneously eliminating potential internal validity complications that could flaw the outcome of the study. Identifying and resolving potential threats to internal validity was a way of authenticating the instrument in this study: the Brain-Based Learning Survey Questionnaire (BBLSQ) as well as validating the accuracy of data used in the study (Johnson & Christensen, 2007).

Overall, the data collecting process tried to eradicate potential extraneous characteristics or biases, including selection threats and maturation effects as well as attrition or mortality effect. Controlling such factors prevented possible extraneous characteristics from aggregating into a self-fulfilling prophecy. First, a stratified random sampling process was strategically adopted to safeguard against any selection threats that could flaw the internal validity of the study.

Stratified random sampling, according to experts, allows a symmetric distribution of conceivable biases across the grade levels of teachers (elementary, middle school

teachers, high school teachers) in the study (Creswell, 2012; McMillan & Schumacher, 2010). Carter and Porter (2000) also argued that such randomization decreases threats to internal validity of the study. To guard against these threats, the company gathering the data was mandated to conduct its business in accordance with the researcher's requirements.

First, only K-12 teachers qualified as respondents. Second, the company, Qualtrics[®], guarded against potential self-selection bias or attrition threat by tracking respondent's survey completion history and dropping respondents who completed the survey in less than 1/3 of the average survey completion time. Normally, attrition threat or selection bias occurs when non-random participant drop-out throughout the course of the study occurs. Restricting participation to a one-time sitting will help avoid premature drop-outs. Third, to overcome possible maturation effects and lapses in time, the study included only participants who completed the survey at one sitting.

Fourth, based on Mathers, Fox, & Hunn's, (1998) assertion that choosing a large sample size gives a study more power and controls for an unforeseeable mortality effect, this study chose a large sample size. Choosing a large sample size also made it possible to forestall possible mortality or attrition effects typically associated with the sampling process (Creswell, 2012). After the data was downloaded, the principal researcher of this study removed incomplete items from the data before it was analyzed. These interventions were put in place to ensure that the internal validity of the design was strong and that the results from this study can be counted as credible.

Population and Sample

Population

The population for this study was focused on the 3.1 million public-school teachers within the K-12 system in the United States. For the 2017-2018 school year, the National Education Association (NEA, 2018) estimated the K–12 classroom teacher population within the public school system to be 3,126,790.

Selecting K-12 public-school teachers from the nation was necessitated by the fact that among all the educational stakeholders, teachers are the ones affected most by a reform in classroom instructional approaches such as BBL practices. Accordingly, most change experts have described teachers as the indispensable agents of change (Fuller, 1969; George, et al., 2006; Hall & Hord, 2011; Hord, et al., 1987). Indisputably, no investigation of K-12 classroom instructional approaches can be successful without a thoughtful assessment of how teachers will engage with that approach in the classroom.

Sample

Through a stratified sampling approach, a sample of 422 teachers was drawn from the 3,126,790 K-12 public-school teacher workforce in the United States. The sample consisted of elementary school (K-5) teachers, middle school (6-8) teachers, and high school (9-12) teachers.

Given the obvious imbalance in gender and years of teaching experience of K-12 teachers, a stratified sampling process was adopted to avoid selecting a fewer number in any of these subgroups than required for the study. For instance, The National Center for Educational Statistics (2018) report for 2015-16 indicated that about 77% of public-school teachers were females and 23% were males. To ensure that this imbalance does

not tilt the percentages of likely respondents, it was decided to randomly permit a minimum of 52% female teachers to complete the survey as opposed to a minimum of 48% male teachers.

The National Center for Educational Statistics reported a similar imbalance in years of teaching experience. In 2015–16, about 10% of public-school teachers had less than 3 years of teaching experience, 28% had 3 to 9 years of experience, 39% had 10 to 20 years of experience, and 22% had more than 20 years of experience (2018). Thus, it was decided that, at a minimum, a third of each subgroup within the teaching experience domain would be randomly selected from the overall number of respondents to the survey.

Accordingly, the sample ($N = 422$) met the originally specified range of 400-450 participants needed to facilitate a robust MLR analysis for testing and fitting the model. Using a stratified sampling process gave this study the advantage of drawing from each group without interfering with the other demographics in the study (e.g., gender and years of teaching experience).

Hypotheses

Research Hypothesis

H1: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are significant predictors of implementation of BBL practices in K-12 classrooms.

Null Hypothesis

H0: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are not significant predictors of implementation of BBL practices in K-12 classrooms.

Definition of Variables

This section encapsulates the conceptual, instrumental, and operational definitions of the variables in this study, including gender, years of teaching experience, knowledge about BBL, perceptions of BBL, and implementation of BBL practices (for a copy of the survey see Appendix A); for instrumental and operational definitions of the variables, see Appendix B).

Gender

Conceptually, the independent variable gender was defined as the sexual orientation or the sex of a person (boy/girl or male/female). In this study, gender was treated as a dummy independent variable. This study limited the definition of gender to male and female teachers based on a categorical rating to the question, what is your gender? Instrumentally, teachers will answer item 1 (Gender), coded G01, by responding to the question, “What is your gender?” Thus, teachers in this study responded Male or Female to the question. Operationally, 0 = male and 1 = female was to serve as the scale for measurement of responses. Since female teachers outnumber male teachers in the public K-12 school system, this study assigned “female” the number 1 and “male” the number 0.

Years of Teaching Experience

Years of teaching experience represents the number of full-time years a teacher has been teaching professionally since he/she started teaching. Instrumentally, respondents in this study showed their years of teaching experience by choosing from the options “Less than 5 years, 5-10 years, 11-15 years, 16-20 years, and more than 20 years” to answer the item coded YTE04: “How many years have you been teaching full-time?” Operationally, the categories were as ranked with the numbers 1, 2, 3, 4, and 5 (see Appendix A).

Knowledge About Brain-Based Learning

Conceptually, teachers’ knowledge about BBL entailed a sense of their cognitive awareness gained over years of educational training and personal experiences in the forms of factual, conceptual, procedural, and metacognitive learning. Generally, such knowledge accrues from different learning settings, including content or subject matter knowledge acquired during training, pedagogical knowledge acquired from annual professional workshops, and practical skills acquired during years of teaching.

Instrumentally, participants showed their knowledge about BBL practices by responding to 14 items on the BBLSQ, namely: TKBBL06, TKBBL07, TKBBL08, TKBBL09R, TKBBL10, TKBBL11, TKBBL12, TKBBL13, TKBBL14, TKBBL15, TKBBL35, TKBBL39, TKBBL40, and TKBBL41 (see Appendix B). The letter “R” indicates that the item was originally reverse-keyed by Klinek (2009). Operationally, the scale for items TKBBL06, TKBBL07, TKBBL08, TKBBL09R, TKBBL10, TKBBL35, TKBBL39, TKBBL40, and TKBBL41 was based on a 5-point Likert scale ranging from 1 to 5; where, 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 =

Agree, and 5 = Strongly Agree. The scale for items TKBBL11, TKBBL12, TKBBL13, TKBBL14, and TKBBL15 was based on a 5-point Likert scale ranging from 1 to 5; where 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Often, and 5 = Always. Total score was determined by summing answers to items 6-15, 35, and 39-41 for a minimum of 14 and a maximum of 70, using an exact interval scale.

Perceptions of Brain-Based Learning

Conceptually, teachers' perceptions of BBL were described by Wachob (2012) as a view or feeling or belief about BBL as an effective strategy for teaching and learning that can promote teachers' willingness to initiate BBL practices in the classroom. Instrumentally, respondents indicated their perceptions of BBL by answering a set of 13 questions, namely: TP1BBL16R, TP1BBL17, TP1BBL18, TP1BBL19, TP1BBL20, TP1BBL21R, TP1BBL22, TP1BBL23, TP1BBL24, TP1BBL25, TP1BBL36, TP1BBL37, and TP1BBL38. (See Appendix B). The letter "R" indicates that the item was reverse-keyed.

Operationally, the scale for these items was a 5-point Likert scale with responses ranging from 1 to 5; where, 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 = Agree, and 5 = Strongly Agree. Total score was determined by summing answers to items 16-25 and 36-38 for a minimum of 13 and a maximum of 65, using an exact interval scale.

Implementation of Brain-based Learning Practices

Teachers' implementation of BBL practices represents a set of teacher characteristics demonstrating the willingness and frequency with which teachers utilized

or implemented indicators of BBL in their classroom. Such indicators included changing their teaching to adopt a brain-friendly teaching style, attending professional development enhancement programs, and using brain adaptable technologies in the classroom.

In this study, respondents indicated their implementation of BBL practices by answering a set of 9 items. Instrumentally, respondents showed agreement to the first three items (TP2BBL26R, TP2BBL27, and TP2BBL28R) on one scale and the last 6 items (TP2BBL29, TP2BBL30, TP2BBL31, TP2BBL32, TP2BBL33, and TP2BBL34) on a different Likert scale (see Appendix B). The letter “R” indicates that the item was reverse-keyed.

Operationally, items TP2BBL26R, TP2BBL27, and TP2BBL28R were measured based on a 5-point Likert scale with responses ranging from 1 to 5; where, 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 = Agree, and 5 = Strongly Agree. Operational items TP2BBL29, TP2BBL30, TP2BBL31, TP2BBL32, TP2BBL33 and TP2BBL34 were measured by a 5-point Likert scale with responses ranging from 1 to 5 where 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Often, and 5 = Always. Total score was determined by summing answers to items 26-34 for a minimum of 9 and a maximum of 45 points, on an exact interval scale.

Instrumentation and Data

Brain-Based Learning Survey Questionnaire (BBLSQ)

This study adopted the BBLSQ as the main instrument. Previously, it was used for an investigation that collected data from public-school faculties in Pennsylvania. Since it was developed originally by Shelly Klinek (2009), the BBLSQ has been used in

many studies to make quantitative inferences (Mansy, 2014; Wachob, 2012). As a whole, the BBLSQ represents a set of 50 questions divided into five scales, namely:

Demographic (5 items), Knowledge (14 items), Beliefs (13 items), Practices (9 items) and Brain Gym (9). The Knowledge Scale ranges from item 6 to item 15, plus items 35, and 39 to 41; the Belief Scale covers items 16 – 25 and 36, 37, and 38; and the Practice Scale covers items 26 – 34. In this study, the Practice Scale will be used to test implementation of BBL practices. The final section, ranging from item 42 to 50, was used to test Brain Gym and fell outside the context of this study. Hence, those final 9 items (42-50) were not used in this present study (see Appendices 1 and 2).

Wachob's Modification of Klinek's Version of BBLSQ

Out of the 50 questions on the original BBLSQ, questions 3, 4, 5, 15, 16, 25, and 31 were slightly modified from Klinek's (2009) original target population (higher education faculty) to better address the subjects in this study (primary and secondary educators). The specific changes are outlined in Table 1 (next page). Although the instrument adopted for this study was the modified version by Wachob (2012), this study will use items 1 – 41 because the rest do not apply.

Demographic Variables

In this study, three (age, kind of school, and grade level) out of the five demographic items were used. Gender and years of teaching experience were used in this study as independent variables. Due to its dichotomous nature, gender was adopted as a dummy variable. Respondents answered the age item, "what is your age," by selecting from five ordinal divisions (younger than 30, 30-39, 40-49, 50-59, and 60 or older). Next,

respondents expressed the kind of school at which they teach by choosing (No = 0, Yes = 1) to the question “Are you a current public-school teacher?” Finally, for grade level, respondents selected (Elementary [K-5], or middle grades [6-8], or high school [9- 12]) as their answer to the question, “What grade level do you primarily teach?” Finally, respondents indicated their years of teaching experience by selecting from answers “less than 5, 5-10, 11-15, 16-20, and more than 20” to the question, “How many years have you been teaching full-time?”

Table 1

Modifications Made to Original Brain-Based Learning Survey Questionnaire (BBLSQ)

Item #	Original BBLSQ Questions	Modified BBLSQ Questions
3	Are you in the College or School of Education Faculty?	Are you a current public school teacher?
4	How many years have you been teaching in Higher Education?	How many years have you been teaching in public schools?
5	Highest Degree Earned?	What grade level do you primarily teach?
15	Our University has encouraged workshops, conferences, or in-service training on the topic of the newest strategies in classroom teaching.	Our District has encouraged workshops, conferences, or in-service training on the topic of the newest strategies in classroom teaching.
16	Different learning approaches are a waste of time in a University setting.	Different learning approaches are a waste of time in a K-12 setting.
25	I feel all college of education faculty should know how to implement brain-based learning.	I feel all K-12 teachers should know how to implement brain-based learning.
31	I use new and updated information in all my education classes.	I use new and updated information in all my classes.

Data Collection

Using a stratified random sampling technique, a high probability-based sampling approach, a 41-item-survey questionnaire was administered, targeting public-school teachers from the K-12 public school system in the United States. At the end of the survey, a sample of 422 public-school teachers had been drawn from the K-12 school system. A survey methodology was adopted because it enabled selection of a portion of the population from which the findings can later be generalized back to the population. Pinsonneault and Kraemer (1993) defined a survey as a “means for gathering information about the characteristics, actions, or opinions of a large group of people” (p. 77). In this study, using a survey enabled the principal investigator to reach K-12 teachers across the United States effectively.

The survey was administered electronically through Qualtrics[®], an online survey administering company, which allows researchers to develop and administer web-based surveys to targeted samples. Selecting Qualtrics[®] was based on multiple reasons, including Qualtrics[®]’ ability to generate a high response rate with great accuracy. Besides being cost effective, Qualtrics[®]’ greatest asset is the broad membership panel from which it selects respondents. Communication with Qualtrics[®] was by phone and e-mail. After the initial contact, Qualtrics[®] e-mailed a document detailing the contract, costs, and processes for uploading and administering the survey. At the end of the data collection process, Qualtrics[®] sent a link to the primary investigator with an Excel-SPSS compatible version of the data, which was downloaded and cleaned for analysis.

As a web-based data generating company, Qualtrics[®] was able to generate the exact sub-group specifications of our sample from a well-constituted panel base of

responders. Thus, using a stratified random approach, Qualtrics® was able to split responders into homogenous non-overlapping grade levels, namely: elementary teachers, middle school teachers, and high school teachers without altering the other scales such as the gender and years of teaching experience. Thus, employing Qualtrics® made the adoption of a high probability-based data collection approach possible. Altogether, a total of 422 individuals successfully completed all 41 items in the survey.

Data Collecting Ethics

Despite using a renowned web-based data-generating company, this study was grounded in an appropriate research compliance protocols set by the Institutional Review Board (IRB), including safeguarding the privacy, safety, and confidentiality of the participants involved in the study. As part of the survey, the primary investigator for this study uploaded a consent and recruitment letter (see Appendix A) to Qualtrics® which had been certified by the IRB, clearly stipulating that participating in the study would not incur any risk except minimal risks similar to risks of daily life. The letter addressed seven essential areas: the purpose of the study, any benefits for participants, the extent of risk if any, assurance of confidentiality, a voluntary participation inducement for participation, and contact information.

Thus, in keeping with the intent to protect their anonymity, respondents were not asked to disclose their identity and personal information. The recruitment and informed consent letter permitted respondents to freely withdraw or refuse participation in the study at any time if they deemed it convenient, without stating any cause. Meanwhile, participants were informed that data generated would be aggregated and kept in a secure locked place until it was destroyed after the study was completed.

The selection of Qualtrics®, in and of itself, offered the data collection process several ethical advantages. Importantly, Qualtrics® provided timely monitoring across its data centers utilizing what it refers to as “industry standard web application firewalls and DDOS protection using secure servers, encryption which includes one-way encryption, numeric IDs, secure.” Qualtrics® also guaranteed that all its computer equipment (servers, Storage Area Networks [SANs], switches, routers, etc.) were secured via industry standard firewalls and stringent information technology (IT) policies (ESOMAR 28, p. 8). Ethically, such high security measures guaranteed that this present study had adequate safety in terms of respondent privacy and confidentiality.

Furthermore, Qualtrics® ensures that primary investigators abide by all the ethical and consent requirements mandated by the IRB of the primary institution sponsoring the study. Generally, Qualtrics® accepts contracts from principal investigators whose study has been approved by the local IRB. Thus, in order to approve a contract, Qualtrics® required the primary investigator for this study to post an ethical plan, including a consent and recruitment letter certified by the IRB (Appendix C), clearly stipulating the purposes of the study; assurances of safety, privacy, anonymity, confidentiality; and any risks involved in participating.

Validity and Reliability of Instrument

McMillan and Schumacher (2010) have defined validity as “a judgment of the appropriateness of a measure for accurate inferences, decisions, consequences, and use of the result from the scores that are generated” (p. 130). According to Klinek’s (2009), her original version of the instrument, BBLSQ met such inquiry validity standards.

From its design to its approval, validating the BBLSQ by Klinek (2009) was described as exhaustive. Due to the assertion that expert panel validation can conduct content validity of a novel instrument (Gay & Airasian, 2000), the BBLSQ was subjected to a rigorous pilot screening by a panel of seven educational professionals. Following that earlier screening, the BBLSQ was validated by a second panel made up of four education faculty members. For this validation process to be research worthy, the constitution of the panel was based not only on members' experience with BBL and Brain Gym, but also on their proficiency with learning and instruction (Klinek, 2009).

The result showed three scales, namely: the Knowledge, Belief, and Practice Scales. Aside from having three scales, Klinek (2009) noted that "each scale had items that were reverse-keyed to prevent a particular response-set bias known as acquiescing or agreement with a statement no matter what it says" (p. 95). The Knowledge Scale comprised the following 14 items: TKBBL06, TKBBL07, TKBBL08, TKBBL09R, TKBBL10, TKBBL11, TKBBL12, TKBBL13, TKBBL14, TKBBL15, TKBBL35, TKBBL39, TKBBL40, and TKBBL41. The Beliefs Scale comprised 13 items: TP1BBL16R, TP1BBL17, TP1BBL18, TP1BBL19, TP1BBL20, TP1BBL21R, TP1BBL22, TP1BBL23, TP1BBL24, TP1BBL25, TP1BBL36, TP1BBL37, and TP1BBL38. The Practices Scale comprised the following 9 items: TP2BBL26R, TP2BBL27, TP2BBL28R, TP2BBL29, TP2BBL30, TP2BBL31, TP2BBL32, TP2BBL33, and TP2BBL34. The letter "R" indicates that the item was reverse-keyed. Accordingly, a split-half variability test was designed by Gay and Airasian (2000), and the Spearman-Brown correlation test was used to calculate the reliability coefficient of each scale.

Aware that reliabilities should be more than .70 to be considered adequate (Cronbach, 1951), Cronbach's alpha reliabilities were computed to test for the internal consistency of the items for each scale. Two of the three scales (Knowledge and Belief) showed very high-reliability coefficients determined using Cronbach's reliability for Knowledge $\alpha = .79$, Belief $\alpha = .86$, and Practice $\alpha = .64$. Only the Practice Scale showed a lower reliability $\alpha = .64$. However, the Practice Scale was considered acceptable based on Mertler and Charles' (2010) assertion that any reliability above .50 should be deemed suitable (paraphrase of Shelly Klinek's work, 2009).

Data Analyses

This study answered the question, what is the role of teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL as predictors of implementation of BBL practices in K-12 classrooms? Multiple regression analysis was used to answer the research question "What is the role of the following variables: teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL as predictors of implementation of BBL practices in K-12 classrooms?"

MLR is a statistical method used to analyze the relationships among single response items or dependent variables (criteria) with two or more controlled variables (i.e., more than one independent variable or predictor). MLR was an appropriate choice given that the dependent variable in this study (implementation of BBL practices) was continuous in nature and all the independent variables (years of teaching experience, knowledge of BBL, and perceptions of BBL), except gender, were also continuous in nature. Meanwhile, Creswell (2012) has avowed that MLR can accommodate a

dichotomous variable such as gender, provided it is an independent variable (Howell, 2010). As a dichotomous variable, gender acted as a dummy variable.

Choosing MLR offered the study multiple advantages. First, with MLR, the variation in teachers' implementation of BBL practices was explained by the variance of each independent variable (gender, years of teaching experience, knowledge about BBL, and perceptions about BBL) as well as by the combined effect of all the independent variables (Creswell, 2012). Second, using MLR offered a partial support for the hypothesized relationships among gender, years of teaching experience, knowledge about BBL, and perceptions of BBL (Howell, 2010).

Summary

This chapter identified the components of the research study, outlining the methods used to collect the data, as well as the selected sample of participants who were surveyed. The chapter also defines the type of research or research design, the population and the sample, the hypothesis, and the definition of variables. Finally, this chapter describes how the data from the study were analyzed to answer the research questions presented in Chapter 1.

CHAPTER 4

RESULTS

Introduction

The goal of the study was to conduct analyses that answer the research question: what is the role of the following variables: gender, years of teaching experience, knowledge about BBL, and perceptions of BBL as predictors of teachers' implementation of BBL practices in K-12 public-school classrooms in 2019?

This chapter presents the results of the analyses that were conducted. The presentation of results commences with a descriptive analysis of the participants, followed by descriptive statistics (mean, standard deviation, minimum and maximum variations, as well as skewness) for the variables used in the study. The presentation of results continues with an inferential analysis, which includes a report on the related hypothesis testing preceded by the bivariate correlation between predictors and criterion variables.

Descriptive Analysis of Participants

This section of the study presents a report of the statistical overview of the participants, particularly demographics such as gender, age, years of teaching experience, and grade level taught. Respondents in this study were drawn from the K-12 public-school teacher workforce in the United States.

Out of 465 surveys from the K-12 public-school teachers who participated in the online survey executed by Qualtrics®, 422 (90.8%) were deemed complete for analysis. Forty-three (9.2%) of the respondents were eliminated prior to the analysis for not successfully completing all the survey questions. The sample ($N = 422$) met the originally specified range of 400-450 needed to facilitate a robust MLR analysis for testing and fitting the model.

A demographic representation of the 422 participants is presented in Table 2, showing the gender, age, years of teaching experience, and grade level taught of the participants. The output indicated that, in terms of their age, female participants were slightly older than male participants. Out of the total sample of 422, there were 216 (51.2%) females and 206 (48.8%) males. With regards to age, 111 (26.3%) of the participants were less than 30 years old, 156 (37.0%) were 30-39 years old, 89 (21.1%) were 40-49 years old, 50 (11.8%) were 50-59 years old, and 16 (3.8%) were 60 years older and more.

For grade level taught, 140 (33.2%) of the respondents were elementary school teachers, 147 (34.8%) were middle school teachers, and 135 (32.0%) were high school teachers; thus, the groups were close to evenly distributed. Finally, for years of teaching experience, 134 (31.8%) of the respondents have taught less than 5 years, 39 (9.2%) have been teaching for 5-10 years, 41 (9.7%) have been teachers for 11-15 years, 134 (31.8%) have been teachers for 16-20 years, and 74 (17.5%) have been teachers for more than 20 years. The teachers with less than 5 years of experience and those with 16 to 20 years of experience recorded the largest number of participants (134 or 31.8%) each. The group

Table 2.

Demographic Characteristics of Participating Teachers (N = 422).

Variable	<i>n</i>	Percentage
Gender		
Male	206	48.8
Female	216	51.2
Age		
Less than 30 years old	111	26.3
30-39 years old	156	37.0
40-49 years old	89	21.1
50-59 years old	50	11.8
60 or more old	16	3.8
Grade Level Taught		
Elementary School(K-5)	140	33.2
Middle School (6-8)	147	34.8
High School (9-12)	135	32.0
Years of Teaching Experience		
Less than 5 years	134	31.8
5 thru 10 years	39	9.2
11 thru 15 years	41	9.7
16 thru 20 years	134	31.8
More than 20 years	74	17.5

with the fewest respondents was those who have been professional teachers for 5-10 years. Table 2 shows the characteristics of the participants in the study.

Description of Variables

In this section, standard deviation, minimum and maximum scores, and skewness for both the dependent variable (implementation of BBL practices) and the independent variables (knowledge, perception, experience, and years of teaching experience) are reported. The descriptive statistics for implementation of BBL practices were as follows:

$M = 3.6095$, $SD = .73594$; Min (1:00) Max (5:00) and Skewness (-.500). For knowledge, the following scores were found ($M = 3.7783$, $SD = 0.75608$, Min = 1.00, Max = 5.00, Skewness = -.794). For perception, the following were the descriptive statistics: ($M = 3.6706$; $SD = 0.79237$, Min =1.00, Max = 5.00, Skewness = -.743); for gender the descriptive statistics were as follows: ($M = .5118$, $SD = 0.50045$, Min = 0, Max = 1, Skewness = -.048) and for experience, the descriptive statistics were as follows: ($M = 3.70$, $SD = 2.049$, Min = 1, Max = 7, Skewness = -.144). Table 3 shows the overall descriptive statistics of the variables.

Table 3.

Descriptive Statistics of Knowledge, Perception, Gender, Experience, & Implementation of BBL.

Variable	<i>N</i>	<i>M</i>	<i>SD</i>	Minimum	Maximum	Skewness
Gender	422	.5118	.50045	0	1	-.048
Experience	422	3.70	2.049	1	7	-.144
Knowledge	422	3.7783	.75608	1.00	5.00	-.794
Perceptions	422	3.6706	.79237	1.00	5.00	-.743
Implementation of BBL Practices	422	3.6095	.73594	1.00	5.00	-.500

These descriptive statistics show that the mean for the middle school level at 3.673 ($SD=.696$) was higher than both the elementary and high school levels. This indicated that K-12 middle teachers were implementing more BBL practices than the other groups. In comparison, the elementary school mean of 3.53 ($SD=.696$) and the high school mean of 3.622 ($SD=.736$) were close to each other. See Table 4.

The independent variable “years of teaching experience” had five levels: Less than 5 years, 5-10 years, 11-15 years, 16-20 years, and more than 20 years. Table 5 shows that means and standard deviation of teachers’ implementation of BBL practices for the five levels of teaching experience were very similar. From the output, teachers with 11-14 years of teaching experience were implementing the most surveyed brain-based practices with mean ($M = 3.718$) and standard deviation ($SD = .747$). The group

Table 4.

Descriptive Statistics of Implementation of Brain-based Learning Practices by Grade Levels

Source	<i>n</i>	<i>M</i>	<i>SD</i>	<i>SE</i>
Elementary School	140	3.5310	.75725	.06400
Middle School	147	3.6727	.69581	.05739
High School	135	3.6222	.75386	.06488
Total	422	3.6095	.73594	.03583

Table 5.

Descriptive Statistics of Total Group: Implementation of BBL Practices by Years of Teaching Experience.

Years of Teaching Experience	<i>n</i>	<i>M</i>	<i>SD</i>	<i>SE</i>
Less than 5 years	134	3.6493	.71657	.06190
5 to 10 years	39	3.4359	.74726	.11966
11 to 15 years	41	3.7182	.72737	.11360
16 to 20 years	134	3.5904	.76768	.06632
More than 20 years	74	3.6036	.71231	.08280
Total	422	3.6095	.73594	.03583

with less than 5 years of teaching experience scored the second highest ($M = 3.6493$; $SD = .71657$). This was followed by those with more than 20 years of teaching experience ($M = 3.6036$; $SD = .71231$). The group that scored the lowest descriptive statistics was teachers who have had 5-10 years of teaching experience.

Bivariate Correlation Between Predictors and Criterion Variables

From the analysis, five of the bivariate correlations ($N = 422$) are significant at the 0.01 level (1-tailed) including knowledge and perceptions (.856, $p = .000$), knowledge vs. implementation of BBL practices (.795, $p = .000$), perceptions and implementation of BBL practices (.825, $p = .000$), and knowledge by gender (.143, $p = .002$). Except these, the other bivariate correlations, including implementation of BBL practices by gender (.060, $p = .108$), gender vs. experience (-.016, $p = .370$), implementation of BBL practices vs. experience (-.026, $p = .296$), knowledge and experience (-.014, $p = .384$), perception with gender (.101, $p = .019$), and perception by experience (.010, $p = .421$) were not statistically significant, where ($N = 422$). At the .05 level (1-tailed), the bivariate correlation for perception and gender (.101 is significant, $p = .019$). The correlations of the variables are shown in Table 6.

Hypothesis Testing

The null hypothesis in this study stated that public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are not significant predictors of their implementation of BBL practices in K-12 classrooms. An MLR analysis was used to test the null hypothesis; the prediction model was statistically significant, $F(4, 417) = 258.569$, $p < .001$.

The prediction model accounted for approximately 71% of the variance of the implementation of BBL practices ($R^2 = .713$, Adjusted $R^2 = .710$). In this sense, there is enough evidence to reject the null hypothesis and consider the viability of the research hypothesis that stated about BBL, and perceptions of BBL are significant predictors of their implementation of BBL practices in K-12 classrooms. Implementation of BBL practices was found to be predicted significantly by knowledge ($\beta = .337$, $t = 6.586$, $p < .000$) and perception ($\beta = .541$, $t = 10.623$, $p < .000$). Years of teaching experience and gender were not significant predictors of implementation of BBL. (See Table 6). The raw and standardized regression coefficients of the predictors, together with their correlations with implementation of BBL practices, and their squared semi-partial correlations are shown in Table 7. In the model, perception that teachers' gender, years of teaching experience, knowledge received the strongest weight (β square = .29), and was followed by knowledge (β square = .11).

Table 6.

Bivariate correlations (one-tailed) between predictor and criterion variables (N=422).

Variables	2	3	4	5
1. Implementation of BBL Practices	.795**	.825**	.060	-.026
2. Knowledge	-	.856**	.143**	-.014
3. Perceptions	-	-	.101*	.010
4. Gender	-	-	-	-.016
5. Years of Experience	-	-	-	-

Note: ** Correlation is significant at the 0.01 level (1-tailed)

* Correlation is significant at the 0.05 level (1-tailed)

Table 7.

Standard Regression Results

Model	<i>b</i>	<i>SE-b</i>	β	<i>t</i>	<i>p</i> =	Pearson <i>r</i>	<i>sr</i> ²
Constant	.434	.109					
Knowledge	.328	.050	.337	6.586	.000	.795	.173
Perceptions	.546	.051	.541	10.623	.000	.825	.279
Experience	-.010	.009	-.027	-1.036	.301	-.026	-.042
Gender	-.063	.039	-.043	-1.617	.107	.060	-.027

Note: the dependent variable was practice. $R^2 = .713$, Adjusted $R^2 = .710$; sr^2 is the square-semi partial correction.

Summary

The goal of the study was to test the null hypothesis which stated that teachers' gender, knowledge of BBL, perception of BBL, and years of teaching experience are not significant predictors of their implementation of BBL practices in K-12 classrooms. The chapter reports the analysis of the inferential statistical techniques employed to examine the relationships between and among the teachers' implementation of BBL practices, knowledge, perception, years of teaching experience, and gender.

The chapter presented a review of the analysis of the participants and variables used in the study. First, a descriptive analysis of participants was presented, capturing the demographic descriptions such as gender, age, years of teaching experience, and grade level that characterized the sample. Second, a review of the statistical description of the variables was presented. Major descriptive statistics were as follows: implementation of BBL practices ($M = 3.6095$, $SD = .73594$); knowledge about BBL ($M = 3.7783$, $SD = 0.75608$), perceptions of BBL ($M = 3.6706$; $SD = 0.79237$); gender ($M = .5118$, $SD = 0.50045$), and years of teaching experience, ($M = 3.70$, $SD = 2.049$).

To test the null hypothesis, MLR analysis was used to test the null hypothesis. In this test, all the bivariate correlations except knowledge and perceptions (.856, $p = .000$), knowledge and implementation of BBL practices (.795, $p = .000$), perceptions and implementation of BBL practices (.825, $p = .000$), and knowledge and gender (.143, $p = .002$) were statistically significant at .01 level (1 – tailed). The prediction model was statistically significant, $F(4, 417) = 258.569$, $p < .001$, accounting for approximately 71% of the variance of implementation of BBL practices ($R^2 = .713$, Adjusted $R^2 = .710$). Hence, the null hypothesis (H_0) which stated that teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are not significant predictors of their implementation of BBL practices in K-12 public classrooms was rejected.

CHAPTER 5

DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

Introduction

In spite of the recent increases in neuroscience and cognitive psychology research that support a brain-based approach to teaching and learning, most teachers do not understand the roles of the brain in learning and instruction. For many years, most American schools have adopted a teacher-centered approach a priori to guide instruction, because it relies on behavior-management related strategies, assuring teacher control of the classroom. This gap between research and practice has grown wider in recent years, in part because policy-makers have enacted policies, including testing, which are inimical to current research findings. Hence, a growing apathy has developed among teachers and school administrators toward the implementation of BBL practices.

In this study, Multiple Regression Analysis was conducted to test the null hypothesis that public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL were not significant predictors of their implementation of BBL practices in K-12 classrooms. This chapter presents a summary, background, and findings of the study with interpretation and discussion of those findings. Implications of those findings and recommendations for practice and future research are included.

Purpose of the Study

The purpose of this study was to investigate whether public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL were predictors of implementation of BBL practices in K-12 classrooms.

Summary of the Literature

The crossroads of medical and educational research about BBL was characterized in the reviewed literature as a recent breakthrough which has made it easier to explore teaching and learning from the standpoint of brain function and processes (Rehman & Bokhari, 2011; Zadina, 2015). This breakthrough in medical research, particularly in the neuroscience and cognitive psychology fields, was made possible by brain-imaging techniques such as MRI, PET, fMRI, and brain recording techniques, including EEG, ERP, and TMS. Based on these findings, researchers can now link cognitive processes (e.g., attention, memory, and perception) with pattern recognition, knowledge representation, language, problem-solving, reasoning, and decision-making (Rehman & Bokhari, 2011, Jensen 2000, 2005; Klinek, 2009; Mansy, 2014).

According to these findings, BBL practices are effective instructional strategies that produce higher achievement among students (Avaci & Yagbasani, 2004; D'Amato & Wang, 2015; Davis & D'Amato, 2014; Duman, 2006; Mercer, 2016; VanDevender & Rice, 1984; Waters, 2005). Therefore, the literature argues that the most effective instruction is designed according to the natural ways the brain learns (Caine & Caine, 1991; Davis & D'Amato, 2014; Jensen, 2005, 2008; Wolfe, 2001).

BBL experts agree that 12 overarching principles, designed by Caine and Caine (1990), remain the cornerstone for BBL. These include

1. The brain is a parallel processor.
2. Learning engages the entire physiology.
3. The search for meaning is innate.
4. The search for meaning occurs through patterning.
5. Emotions are critical to patterning.
6. The brain processes parts and wholes simultaneously.
7. Learning involves both focused attention and peripheral perception.
8. Learning always involves conscious and unconscious processes.
9. We have at least two different types of memory: A spatial memory system and a set of systems for rote learning.
10. We understand and remember best when facts and skills are embedded in natural, spatial memory.
11. Learning is enhanced by challenge and inhibited by threat.
12. Each brain is unique. (pp. 87-96)

Regardless of the many calls from brain education experts for reform and the exhaustive scholarly opportunities created by researchers, the problems in how instruction is conducted have persisted; a gap has continued between the existing research and teacher practice. While historically teachers have had a meaningful impact on school curricula; with the introduction of national curricula, content standards, and federally mandated assessment tools, teachers' approaches to instruction have changed. To enforce these new regulations, teachers are evaluated now on the basis of test results which only infer that students have learned. Because these forces have reduced teacher control over what (content) and when (occasion) to teach, teachers have involuntarily adopted test-based teaching. Consequently, teachers now have less opportunity to base their lesson plans on current research in brain education. Thus, this gap between research and practice has created a dilemma for policy-makers, educational leaders, teachers, and students.

The literature review discussed whether teachers were unwilling to implement BBL with regards to their gender (Erlauer, 2003, Gurian & Stevens, 2010; Laird, et al., 2007; Ruigrok et al., 2014), years of teaching experience (Martin, 2006; Ridley, 2012;

Young, 2016), lack of knowledge about BBL (Jensen, 2005; Wachob, 2012; Young, 2016), and perceptions of BBL (Roberts-Perrin, 2012; Wachob, 2012).

Over the years, concerns have developed regarding the practical implications of any ties between teachers' functional capabilities and their gender on their willingness to implement BBL (Bruning, Schraw, Norby, & Ronning, 2004). Meanwhile, recent breakthroughs in cognitive neuroscience have raised pertinent questions about the role of gender in the implementation of BBL (Wilkins & Gamble, 2013). Such concerns have spurred a flood of scientific inquiries into whether teachers' gender is a significant determinant of their intent to implement BBL in the classroom. A study by Cahill (2016) acknowledged that neurological sex differences are receiving increased attention; others have concluded that gender differences in brain morphology could have an effect on cognition (Allen et al., 2003; Ruigrok et al., 2014). Accordingly, Laird and colleagues (2007) posited, "understanding how and why men and women teach differently is critical to assisting faculty in their efforts to improve their teaching" (p. 3).

That said, the literature provided divergent standpoints about teacher gender and BBL. One school of thought argued that teachers' functional capabilities and their gender are highly correlated (Gurian & Stevens, 2010). A second school of thought has characterized the debate on the role of teacher gender in cognition as inconclusive (Hayes et al., 2004; Taggart, et al., 1997).

Those in favor of the effect of gender differences on cognitive skills have defined cognitive skills as "sources of individual differences in performance in cognitive tasks, including factors such as intelligence, memory capacities, attention focus, knowledge base, strategies, and processing speed" (Galotti, 2014, p. 409). Along these lines, Galotti

(2014) has concluded that “knowing that a person is male or female can improve your guess about how well he or she might perform on a specific cognitive task (such as visual-spatial or quantitative) by at most only 5%” (p. 368). However, through brain mapping neuroscientists have affirmed that many differences in the anatomy of the brain are present between genders (Galotti, 2014; Gurian & Stevens, 2010). Therefore, the question of whether teacher gender affects implementation of BBL practices remained.

Teachers’ knowledge about BBL is important because it affects the use of BBL strategies. While knowledge of such strategies has been deemed central to effective teaching (Danielson, 2007; Jensen, 2005), because of inadequate attention from policy makers, school leaders, educators, and teacher educators, most classroom teachers still lack the requisite knowledge needed for actual practice. In addition, those decision makers are paying attention to critics of BBL, (Goswami, 2004; Jensen, 2005; Klinek, 2009; Wachob, 2012). The literature expressed the belief of the experts that knowledge of brain-compatible instruction is essential for educators because, fundamentally, teaching and learning demand knowledge of how the brain works, including how it acquires, processes, and constructs information (Jensen, 2005; Klinek, 2009, Sousa, 2011; Wachob, 2012).

Given that BBL bases most of its conclusions on cognitive psychology and cognitive neuroscience, the discussion regarding the foundational knowledge requisite for the implementation of BBL has drawn strong criticism from a few cognitive psychologists. Bruer (1997) in particular has discounted the knowledge supposedly needed by teachers to implement BBL as unnecessary, irrelevant, and oversimplified; he argues that brain science remains unready to serve as the basis for pedagogical practice.

Within the literature, Bruer's (1997) main argument is that knowledge about animals "is still not enough to guide educational practices" (p. 4) for humans. Much of the literature appears to support Bruer's critique because he points out salient issues that should be addressed, especially those regarding the practical implications from neurophysiology. Others have concluded that Bruer (1997) may have overlooked relevant neurologically related propositions from BBL theory, including the presumed salience of attention, memory, information retrieval, visual imaging, sleep, emotion, activities, and reasoning for the teaching-learning process (Jensen, 2005; Lyons, 2003; Politano & Paquin, 2000). Against this backdrop, several experts have argued that although teachers should not and cannot master neurology or similar disciplines before they apply significant findings to their work, the results from brain research that are well understood can be applied while investigation of other areas persists (Klinek, 2009; Wachob, 2012).

Most researchers believe that the question that should be asked is not whether enough information has been generated to substantiate curriculum reform, but rather whether current discoveries can be used to fine-tune teaching and learning. The answer, they presume, lies in the massive call by experts for teacher education programs to strike a balance between the academic theory they offer and the actual classroom realities teachers face (Caine & Caine, 2005; Jensen, 2005; Sousa, 2011; Sylvester, 1995; Wachob, 2012).

The literature includes perceptions about BBL because its association with the implementation of BBL is relevant. Experts have demonstrated that, fundamentally, people see reality through different lenses (Caine & Caine, 1990; Pajares, 1992). Thus, the relationship between teachers' perceptions and their implementation of BBL is based

on their beliefs about the value of their current practice (Klinek, 2009, Mansy, 2014; Siercks, 2012; Wachob, 2012). Most experts have traced the genesis of a teacher's perception to the pre-service teaching period, during which the neophyte teacher embraced the practices of experienced teachers in the field (Kagan, 1992; Lortie, 1975; Stuart & Thurlow, 2000).

Aside from its roots in years of apprenticeship, teachers' perceptions of BBL were traced to teachers' views of BBL as a learner-centered and constructivist instructional approach (Caine & Caine, 1990; 2005; Jensen, 2005; Sousa, 2011); to its impact on one's teaching style and personal achievement as a professional; to its ability to improve student achievement; and to its implications for learning in general (Denton, 2010; Goodlad, 2004; McDermott, et al., 2001; Roderick & Engel, 2001, Weiss & Pasley, 2004).

Several authors believe that a teacher's negative perceptions of BBL can lead to a feeling of inadequacy and a lack of confidence which can negatively affect the courage to implement it as a new pedagogical practice (Denton, 2010; Klinek, 2009, Mansy, 2014; Siercks, 2012; Wachob, 2012). In separate studies, Klinek (2009) and Wachob (2012) confirmed that such an unbalanced perception, if not corrected, can impede teachers' readiness to implement BBL practices in the classroom.

The variable "years of teaching experience" was included in the literature review; however, little has been done to investigate the relationship between years of teaching experience and implementation of BBL. In this study, years of teaching experience was synonymous with tenure or number of years of full-time teaching. The literature

presented two opposing views about whether years of teaching experience and implementation of BBL practices in classrooms are connected.

One school of thought indicated that there is a negative relationship between years of teaching experience and teachers' implementation of BBL experiences (Klinek, 2009; Mansy, 2014; Wachob, 2012). By contrast, another school of thought has suggested that a positive relationship exists between years of teaching experience and teachers' implementation of BBL (Galotti, 2014; Morris, 2010). The foundation of this debate dates back to Dewey's (1916, 1996) assertion that being the primary facilitators of change, teachers must possess the ability to self-regulate their learning experience by reflecting over their years of teaching experience vis-à-vis the effectiveness of the approaches they adopt. In fact, experts tie such meaningful introspection with a growing positive disposition that translates into teacher confidence, self-efficacy, and satisfaction with their professional practice (Brinkley, 1999; Crossman & Harris, 2006; Koustelios, 2001; Mertler, 2002; Morris & Pai, 1976).

Several theorists presented the argument that the more ways something is learned or experienced, the more memory pathways are built (Craig, 2003; Galotti, 2014; Goswami, 2004; Jensen, 2008). Other brain-based experts such as Galva'n (2010) and Zadina (2014) have affirmed that learning occurs best when people gain experience or repeatedly practice activities controlled by parts of their visual, motor, sensory, or coordination systems.

Summary of the Methodology

A non-experimental quantitative research study with a correlation design was conducted to investigate whether public-school K-12 teachers' gender, years of teaching

experience, knowledge about BBL, and perceptions of BBL are predictors of their implementation of BBL practices in the United States. A correlational design allowed the simultaneous study of the five variables in this study, and permitted the use of MLR to analyze the data gathered.

MLR constituted an appropriate statistical approach because the dependent variable, implementation of BBL practices, was continuous in nature and all the independent variables: years of teaching experience, knowledge about BBL, and perceptions of BBL, except gender, were continuous in nature. As a robust analytic technique, MLR offered the advantage of explaining the variation between teachers' implementation of BBL practices and each independent variable as well as the combined effect of all the independent variables.

This study was based on a single research question that stated: What is the role of public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL as predictors of implementation of BBL practices in K-12 classrooms.

Two theoretical perspectives underpinned the study, namely, constructivist learning theory and connectionist approaches to learning. Philosophically, constructivists espouse that meaningful learning occurs when learners actively try to make sense of reality by interpreting the world around them (Geary, 1995; Kim, 2005; Mayer, 2004; Riegler & Quale, 2010). The connectionist approach thrives on the assumption that information flowing from one process to another is not controlled by a central or single processing unit, as was previously hypothesized by the information processing experts (Galotti, 2014).

Data Collection

In this study, data was collected using a stratified random online surveying process. Forty-one of the items from the 50-question questionnaire, BBLSQ, an instrument developed by Klinek (2009) and modified by Wachob (2012), were administered electronically through Qualtrics[®], an online survey administration company that allows researchers to develop and administer web-based surveys to targeted samples.

The goal was to generate a sample of 420 to 450 K-12 public-school teachers within the United States. The study used a stratified random sampling process, which permitted a symmetric distribution of potential biases across the grade levels: elementary, middle school, and high school teachers. Out of the 465 respondents who participated in the anonymous survey, 422 (90.75%) successfully completed all the items. The 43 (9.25%) respondents who did not complete the survey were eliminated and dropped from the sample before initiating data analysis. Of the 422 participants in the sample, 51.2% were females.

Hypotheses

The study was based on the following research and null hypotheses:

Research Hypothesis

H1: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are significant predictors of implementation of BBL practices in K-12 classrooms.

Null Hypothesis

H0: Public-school teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL are not significant predictors of implementation of BBL practices in K-12 classrooms.

Major Findings

This study investigated four independent variables presumed to predict the implementation of BBL practice in public-school K-12 classrooms. A survey sample of 422 public K-12 teachers was analyzed via a prediction model. A single multifaceted research question asked whether teachers' gender, years of teaching experience, knowledge about BBL, and perceptions of BBL predicted their implementation of BBL practices in their classroom. By answering survey questions, teachers reported their gender, years of teaching experience, knowledge about BBL, perceptions of BBL, and implementations of brain-based practices. The prediction model was statistically significant and accounted for a large percentage (71%) of the variance in implementation of BBL practices.

On the one hand the study found that knowledge about BBL and perceptions of BBL were significant predictors of teachers' implementation of BBL practices in K-12 classrooms (perception: $\beta = .541$ and knowledge: $\beta = .337$). From this result, it was concluded that teachers' perception of BBL was 1.6 times stronger as a predictor of teachers' implementation of BBL practices than was teachers' knowledge about BBL. On the other hand, the study found that gender and years of teaching experience were not significant predictors of teachers' implementation of BBL practices in K-12 classroom.

Discussion of the Major Findings

The goal of this section is to deduce a meaningful connection between the major findings of this study, the theoretical frameworks, and the reviewed literature.

Functionally, the two frameworks, constructivist theory of learning and connectionist approach of cognition, were designed to give more meaning to the findings of this study and make it generalizable to the K-12 teacher population in the country. In concert with the literature review, these two theoretical frameworks helped to structure the study in a way that demonstrated linkages, illustrated trends, and provided an overview of the variables investigated (Merriam & Simpson, 2000). Without the constructivist theory of learning and the connectionist theory of cognition, the vision for this study would have been unclear. Metaphysically, constructivists view meaning or reality as a paradigm to be constructed. In comparison, connectionists understand that the various cognitive processes are supported by different patterns of activation.

The primary findings of this study are that teachers' perceptions and teachers' knowledge are significant predictors of teachers' implementation of BBL practices in the classroom. Perceptions about BBL were by far more important than knowledge of brain-based teaching practices. By contrast, the study found that teacher gender and years of teaching experience are not significant predictors of teacher implementation of BBL in K-12 classrooms.

A concise review of the study's findings can identify many of relevant linkages between significant principles of the theoretical frameworks, the reviewed literature, and the findings themselves. In this study, the findings about teachers' perceptions agree with the principal tenets of the two overarching theories in relation to teachers'

implementation of BBL practices. In both the constructivist theory of learning and the connectionist approach of cognition, teachers' perceptions are rated as a strong factor underlying the quality of their implementation of BBL practices (Fennema, et al., 1996; Pajares, 1992; Polly, et al., 2013). In fact, constructivists (Callahan, Clark, & Kellough, 2002; Ertmer, 2005; Goodlad, 2004; Weiss & Pasley, 2004) and connectionists (Caine, Caine, McClintic, & Klinek, 2005; Caulfield, Kidd, & Kocher, 2000; Winters, 2001) have concluded that before changing their professional practice, teachers normally review the context of teaching in comparison with their existing beliefs or perceptions.

This finding concurs with the general assertion that perception resides at the heart of human behaviors, beliefs, decisions, and actions (Caine & Caine, 1997; Sternberg, 2009) and with the conclusion that the way teachers perceive reality can shape the way they think about education and teaching. Meanwhile, the literature portrayed teachers as willing to try new approaches when they perceive them to be effective (Duman, 2010; Richards & Skolits, 2009).

Again, the literature showed that teachers' perceptions of BBL are grounded in perceptions of what they are already doing (Klinek, 2009, Mansy, 2014; Siercks, 2012; Wachob, 2012). For instance, teachers' perceptions can be affected by whether teachers view a particular teaching approach as tedious; this can include perceptions of BBL practices. In fact, Bayat (2012) found that teachers will normally refuse to implement a teaching approach if they perceive it as tedious and counterproductive to their practice. On the contrary, Denton (2010) has argued that teachers are more likely to adopt more effective teaching practices when they have a conscious awareness of the impact that their beliefs have on student learning. Jensen (2005) also observed that improving

teachers' perceptions of BBL in turn improved their classroom instruction as well as student achievement. Undoubtedly, change initiatives that seek to improve K-12 teachers' implementation of BBL practices must first focus on improving teachers' perceptions of BBL.

Philosophically, constructivists hold knowledge as a phenomenon that must be constructed and not discovered. At the epistemology level, constructivists believe that knowledge of any form constitutes an interaction between the learner and the environment (Jonassen, 1991; Yildirim, 2014). As such, constructivists hold that such knowledge can be gained through a reflection on the mental outcome of a mental interaction with the environment. Connectionists assume that such knowledge is stored as connection weight, meaning the form of knowledge to be constructed is determined by the nature of connections stored serially (McClelland, 1988).

Like perception, this study found that teachers' knowledge was a significant predictor of their implementation of BBL practice in K-12 classrooms. This finding aligns well with constructivist (Good & Brophy, 2000; Rowan, Correnti, & Miller, 2002) and connectionist (Cleeremans & McClelland, 1991) positions as far as implementation of BBL practices is concerned. Cleeremans and McClelland (1991), staunch connectionists, argued that connectionist teachers are more effective when they select instructional data and techniques knowledgeably, purposefully, or rationally. The reviewed literature emphasized the underlying connectionist argument that teacher effectiveness of implementation of such knowledge resides in their understanding of the behavioral and mental states of learners in addition to understanding the neural processes

that underpin cognition (Mareschal et al., 2007; McClelland & Cleeremans, 2009; Rogers & McClelland, 2004).

This finding also agrees with conclusions in the literature that improving teachers' knowledge about BBL will substantially improve their implementation of BBL practices in the classroom (Caine & Caine, 1990; Mansy, 2014; Denton, 2010; Siercks, 2012; Sousa, 2011). So, the finding that knowledge is a significant predictor of teachers' implementation of BBL suggests that teachers will implement BBL if they know more about it and if they believe that it will improve their work and student achievement. In fact, in a recent study, Iserbyt, Ward, and Li (2015) found that improving teachers' knowledge as a whole does have a direct impact on their pedagogical content knowledge and student performance in physical education.

Thus, as far as teachers' knowledge is concerned, the literature expressed the experts' belief that knowledge of brain-compatible instruction is essential for educators because, fundamentally, teaching and learning demands knowledge of how the brain works, including how it acquires, processes, and constructs information (Jensen, 2005; Klinek, 2009, Sousa, 2011; Wachob, 2012). Danielson (2007) argued strongly that “without proper knowledge teachers can find the complexities of teaching rather unnerving” (p. 170). Caine and Caine (1990) proposed that one way to improve teachers' knowledge about BBL is for them to understand the 12 overarching principles, referred to earlier, which serve as the cornerstone for BBL (Caine & Caine, 1990).

Clearly, BBL practicing teachers must draw from cognitive neurological, psychological, and educational research in a continuous search to provide the best possible instructional environment for students. Accordingly, Jensen (2005) commented,

“Each educator ought to be professional enough to say, ‘Here’s why I do what I do” (p. 409). Contextually, teachers will be able to repeat Jensen’s words when they become knowledgeable enough about BBL practices.

Meanwhile, Sousa (2011) has grouped the knowledge needed by teachers under three headings, namely: content or subject-matter knowledge, pedagogical knowledge or applied knowledge of how to implement BBL practices, and discrete teaching skills needed to effectively implement BBL practices in their classrooms. Therefore, K-12 teachers need to have foundational knowledge about BBL practices during their educational training and/or via continuous professional development programs. School reforms that seek to facilitate the implementation of BBL within the K-12 school system must incorporate these major divisions of knowledge into those programs in order to be successful.

The reviewed literature also depicted connectionism as a cognitive theory that teaches that reality is learned through repeated exposure to stimuli from the environment (McClelland & Rumelhart, 1986). Meanwhile, the study found that years of teaching experience is not a significant predictor of BBL. Additionally, both the constructivist theory of learning and connectionist approach to cognition emphasized personal or individual differences in learning and environmental factors in learning as common determining factors of teacher’s adopting of reality and BBL (Caine and Caine (1997; Halpern, 2012; Kahveci and Ay, 2008).

Philosophically, the constructivist theory of learning (Yıldırım, 2014) and the connectionist approach to cognition (Halpern, 2012; Kosciuk, O’Leary, Moser, Andreasen, & Nopoulos, 2009) depict learning as an active and internal processing of reality. These

two theoretical frameworks emphasize personal or individual differences such as gender differences in learning as the basis for teachers' adoption of reality and BBL (Caine and Caine (1997; Halpern, 2012; Kahveci and Ay, 2008). Yet, another part of the reviewed literature concluded that differences in male and female teachers explains various internal differences in cognitive ability and skills such as storage and retrieval of memory (Putnam et al., 2008; Zaidel & Sperry, 1974), the allocation of attention and arousal (Giedd et al., 1994; Giedd et al., 1996; Levy, 1985; Levy & Heller, 1992), self-awareness, self-motivation, and self-management levels (Jensen, 2005; Galotti, 2014; Gurian & Steven, 2010; Sousa, 2011) as well as internal physiological brain processes including differences in lateralization and others (Gabriel & Schmitz, 2007; Gauthier, Duyme, Zanca, & Capron, 2009; Ruytjens, et al., 2007). On the surface, from this standpoint, it seemed as though the varied gender-specific internal cognitive abilities would have a direct impact on teachers' implementation of BBL (Erlauer, 2003; Grasha, 1994; Jensen, 1995, 2000; Wolfe, 2001; Measor & Sikes, 1992). However, this discussion of the literature review and theoretical framework as having relevance undertones on teachers' implementation of BBL in K-12 classrooms proved rather inconsistent with the finding.

Implications of the Major Findings

This section includes an introspective examination of the implications of the findings for further research and educational practice. The findings suggest the need to initiate a reform that improves teachers' perceptions of and knowledge about BBL in ways that motivate teachers to implement BBL practices in their classrooms. Reforming teacher education curricula to include training in brain-based theory and practices will

properly equip teachers before their teaching assignment. During their tenure as teachers, school districts and educational leaders can organize regular professional development programs to refresh teacher memories about brain-compatible education.

The finding also offers educational stakeholders the opportunity to rethink the theory of BBL as a didactic approach that can lend fresh perspectives to the reforms currently being advanced within K-12 education. Researchers believe that perception is foundational to human attitudes, behaviors, and actions. In fact, it has been considered the mutual factor that guides human interpretation of reality, which includes teachers' implementation of BBL practices (Caine & Caine, 1990; Sternberg, 2009). Hopefully, if teachers' perceptions of BBL are positive, they will be willing to implement it.

Furthermore, researchers view teachers as the indispensable agents of school change, which make teachers' perceptions more crucial for the implementation of instructional reforms (Rehman & Bokhari, 2011; Crawford, Gordon, Nicholas, & Prosser, 1998; DuFour & Fullan, 2013). Indisputably, no reform of K-12 curricula or teacher education programs can be successful without a thoughtful assessment about how to engage teachers in the change process.

Therefore, to effectively gauge the level of teachers' engagement in a particular educational activity, particularly curriculum development, it is important to pinpoint specific teacher concerns that fuel their perceptions of BBL as an instructional approach (Friel & Gann, 1993; Hord, et al., 1987). Doing this will offer school reformers the opportunity to understand the role teachers play in the implementation process (Rehman & Bokhari, 2011, Crawford et al., 1998; Dufour & Fullan, 2013).

Usually, during an implementation process a teacher may experience an unusual dilemma: whether to utilize the product to benefit their students or to manage the concerns that undermine his/her perceptions. The following paraphrase captures Ramparsad's (2000) depiction of such a quandary. Despite the fact that they want to enjoy teaching and watch their students develop interests and skills in their own interest area, teachers face many impediments regarding their contribution to implementation of innovations. Thus, in part, the success of a reform will depend on how well reformers ensure that these concerns do not affect teachers' perceptions of BBL practices. In fact, Alsubaie (2016) wants reformers to know that getting teachers involved in the curriculum development process is an effective path to successful curriculum reform.

Coupled with these challenges is the argument that brain-compatible education is a fad rooted in an unethical scientific method. Such criticism was based on assumptions that characterized neuroscience as a specialized field that should be reserved for experts and not amateurs such as teachers and students (Bruer, 2006; Goswami, 2004; Zambo, 2013). Such a characterization of BBL as a premature convergence between cognitive neuroscience and educational practice appears to have had a degenerative effect on teachers' perceptions of BBL as a whole (Bruer, 2006; Colnerud, 2006; Wasserman & Zambo, 2013).

In addition to perception, the finding that knowledge is a predictor of BBL practices among K-12 teachers carried additional field and theoretical implications. Primarily, this finding portends that instruction within K-12 school settings requires a reform initiative fueled by research. Here too, many researchers have the view that such research-based reform initiatives must start with teacher education programs and continue

as lifelong professional development during the tenure of a teacher (Adair-Hauck & Donato, 1994; Jensen, 2005).

In fact, the kind of knowledge to be taught in teacher education and lifelong programs should be consistent with the knowledge encapsulated in the underlying theoretical frameworks of this study and the reviewed literature, such as those that emphasize collaboration, learner autonomy, generativity, reflectivity, and active engagement. In recent years, the notion of ensuring successful teacher practices has focused on the closing of the ever-widening gap between researchers and teacher educators. Researchers believe that closing the gap between research and practice will improve instruction and learning (Baratz-Snowden, 2009; Elmore, 1996; McLaughlin & Talbert, 1993).

Erlauer (2003), a renowned brain-based theorist, has suggested that promotion of a prior knowledge of brain-compatible instructional strategies is a necessary indicator of teachers' capability to progress through the stages of reform when implementing BBL practices. He argued that knowing more about BBL will not only shape education majors' perceptions about it, but also will motivate them to own BBL as their practice before entering the field.

Teacher training programs now have the opportunity to reconceptualize school pedagogy against the backdrop of this complexity, meaning that BBL could be one of the key areas of training for education students before releasing them into the field. Coupled with this, school leaders can organize regular professional development programs for teachers in the field. Although reformers can include gender issues, they should be careful not to burden teachers by stereotyping contemporary gender-biased issues.

Finally, the outcome of the study indicated that despite the extensive literature on the role of gender and of years of teaching experience in instruction, they are not significant predictors of BBL practices in the public-school K-12 classrooms. For both gender and years of teaching experience, given the importance of students' learning styles and human functionalities vis-à-vis the findings surrounding gender, the implication is that little or no attempt should be made to highlight differences that might erupt into stereotyping either male or female teachers. The findings indicated that learning the relationship between gender and implementation of BBL practices at the teacher training level or at professional development programs will not have an adverse effect on teachers' perception of BBL, unless the training negatively affects both sexes.

The reviewed literature also depicted connectionism as a cognitive theory that teaches that reality is learned through repeated exposure to stimuli from the environment (McClelland & Rumelhart, 1986). Meanwhile, the study found that years of teaching experience is not a significant predictor of BBL. Additionally, both the constructivist theory of learning and the connectionist approach to cognition emphasized personal or individual differences in learning and environmental factors in learning as common determining factors of teacher's adopting of reality and BBL (Caine and Caine (1997; Halpern, 2012; Kahveci and Ay, 2008).

Philosophically, the constructivist theory of learning (Yıldırım, 2014) and the connectionist approach to cognition (Halpern, 2012; Koscik, et al., 2009) depicted learning as an active and internal processing of reality. These two theoretical frameworks emphasized personal or individual differences such as gender differences in learning as a basis for teachers' adoption of reality and BBL (Caine and Caine (1997; Halpern, 2012;

Kahveci and Ay, 2008). Yet, another part of the reviewed literature concluded that differences between male and female teachers explains internal differences in cognitive ability and skills such as storage and retrieval of memory (Putnam et al., 2008; Zaidel & Sperry, 1974), the allocation of attention and arousal (Giedd et al., 1994; Giedd et al., 1996; Levy, 1985; Levy & Heller, 1992), self-awareness, self-motivation, and self-management levels (Jensen, 2005; Galotti, 2014; Gurian & Steven, 2010; Sousa, 2011) as well as internal physiological brain process such differences in lateralization and many more (Gabriel & Schmitz, 2007; Gauthier, Duyme, Zanca, & Capron, 2009; Ruytjens, Albers, van Dijk, Wit, & Willemsen, 2007). On the surface, it seemed from this standpoint as though the varying internal cognitive abilities will have direct impact on teachers' implementation of BBL (Erlauer, 2003; Grasha, 1994; Jensen, 1995, 2000; Wolfe, 2001; Measor & Sikes, 1992). However, this discussion of the literature review and theoretical framework as having relevance undertones on teachers' implementation of BBL in K-12 classrooms proved rather inconsistent with the finding.

Recommendations for Practice

In view of the need for changes in teacher education and in teacher practice, the following two recommendations are presented.

1. First, teacher education curricula must include training in brain-based theory and practices to properly equip teachers before their teaching assignment. Such training can be included in professional development programs organized by school district leaders to improve teacher skills in implementing brain-compatible education. Experts have shown professional development training programs have an optimistic impact on teachers' willingness to implement BBL in the classroom (Bayar, 2014; Carew &

Magsamen, 2010). However, despite such positive relationships between professional development programs and teachers' implementation of BBL, educational leaders and school districts have done little to hold professional development programs with a particular emphasis in BBL (Dubinsky, Roehrig, & Varma, 2013; Han, 2014; Young, 2016). Thus, in order for teachers to implement BBL practices in their classrooms effectively, teachers must have an opportunity to model or practice brain-based theory before implementing it in the classroom (Danielson, 2007; Goswami, 2004; Jensen, 2005; Klinek, 2009; Wachob, 2012). In fact, according to experts, optimizing teachers' 'motivation to implement an innovation such as BBL in the classroom largely depends on the prior experience teachers have had with the innovation (Brophy, 1983; Snowman, et al., 2009).

2. Second, reforms in K-12 education must retreat from test-based practices and, rather, encourage BBL strategies while finding more effective ways to measure student achievement. Fullan (1993) posits that schools require engagement of a lifelong renewal process brought on through reform efforts. Thus, to shift attention from such decades of state and federal education policies, Webb et al., (2007) suggested that school leaders reverse the current emphasis from educational inputs to educational outcomes and from procedural accountability to educational accountability. Encouraging BBL practices over the so-called text-based practices would offer teachers the opportunity to base their lesson plans on current research in brain education.

Recommendations for Research

The results of this study show that relationships exist between teachers' perceptions and knowledge as far as their implementation of BBL practices are

concerned. The following recommendations, based on the results of this study and the literature review above, are for researchers who may be interested in conducting future research, based on this study.

1. This study was limited to professional teachers in K-12 schools. However, the literature indicated that teacher education and professional education programs could mount a reform that would facilitate the implementation of BBL in K-12 schools. Thus, future researchers can investigate the relationship between teacher education and professional development programs and the implementation of BBL practices in K-12 schools.

2. This study was limited to a quantitative method. Employing alternative methods such as qualitative or mixed methods research would give researchers an advantage as they conduct direct interviews with teachers and other stakeholders who might be involved. Comparing the importance of mixed method and the non-experimental research method used in this study, McMillan and Schumacher (2010) declared that while non-experimental quantitative studies deal with the extent and rates of relationship between variables; mixed methods techniques, on the other hand, can explain the “how” and “why” underlying those relationships. According to McMillan and Schumacher (2010), mixed methods “allow the study of the process as well as the outcome” (p. 397).

3. The study was conducted in a single time period. As an alternative to a single period study, a longitudinal design could address the trend of implementation with K-12 teachers over time. McMillan and Schumacher (2010) have argued that because longitudinal studies investigate changes in participants over time, researchers can fine-tune their study of the same group of participants over a period of time. In this sense,

future investigators studying the same variables in this study would have the advantage of administering the same instrument to different sample groups. Thus, in a longitudinal study, researchers may survey early-career teachers during the first five years of teaching to analyze trends of implementation trend and or what they have learned about BBL practices since their graduation from teacher education.

Conclusions

Much research has been conducted about implementation of BBL, but little attention has been given to whether implementation of BBL practices is predicted by gender, years of teaching experience, knowledge about BBL, and perceptions about BBL (Wachob, 2012). Certainly, additional research on the relationship between the implementation of BBL and teachers' gender, their years of teaching experience, their knowledge about BBL, and their perceptions of BBL is needed. This study contributes to that research.

On the one hand, the results of this study show that knowledge about BBL and perceptions of BBL have a strong, positive, and significant relationship with implementation of BBL practices. On the other hand, the results indicated that gender and years of teaching experience had no relationship with implementation of BBL.

The outcome of this study necessitates the need for college educators of future K-12 teachers to incorporate BBL theory into their curricula and introduce teachers to it while in training. Additionally, the outcome necessitates the need for school leaders to organize frequent in-service training for new and existing teachers with particular emphasis on how the brain learns and how to teach with that in mind. Further research could examine these relationships in more depth.

APPENDIX A

BRAIN-BASED LEARNING SURVEY QUESTIONNAIRE
(BBSQ) VERSION USED IN STUDY WITH
INFORMED CONSENT

Dear K-12 Public School Teacher,

I am conducting a research study that focuses on the relationship between gender, knowledge, perceptions, concerns, and years of teaching experience and K-12 public school teachers' willingness to implement brain-based learning practices in their classroom. Your participation is greatly appreciated.

Your participation in this study is completely voluntary. As such, you may withdraw at any time if you choose to do so. Your privacy and confidentiality will be maintained throughout this study. You will not be identified in the research report. To ensure this, your responses will be considered only in combination with those from other participants. Additionally, all data will be aggregated and shared confidentially. Only the researcher will have access to the data which will be kept in a secured place locked.

Meanwhile, there are no risks involved in the study beyond normal minimal risks where minimal risk is defined as being relative to your daily risks. Your participation will not affect your employment in any way.

By checking the yes box below, I confirm that I have received sufficient information regarding the study that all my questions have been satisfied, and I have understood what is involved. I now voluntarily consent to participate in the study.

- ☐ Yes
- ☐ No

1. What is your gender?
 - ☐ Male
 - ☐ Female
2. What is your age?
 - ☐ Younger than 30
 - ☐ 30-39
 - ☐ 40-49
 - ☐ 50-59
 - ☐ 60 or older
3. Are you a current public-school teacher? (Not on any type of leave, including; medical, personal, educational, disciplinary, sabbatical, etc...)
 - ☐ Yes
 - ☐ No
4. How many years have you been teaching full-time?
 - ☐ Less than 5
 - ☐ 5-10
 - ☐ 11-15
 - ☐ 16-20
 - ☐ More than 20 years
5. What grade level do you primarily teach?
 - ☐ Elementary (K-5)
 - ☐ Middle (6-8)
 - ☐ High School (9-12)
6. I have sufficient understanding of how the brain learns.
 - ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
7. I am comfortable with the use of various learning strategies as part of my classroom teaching.
 - ☐ 1 Strongly Disagree

- ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
8. I am knowledgeable about the use of providing frequent, non-judgmental feedback as a useful tool.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
9. I feel the need to be more adequately trained in the area of how the brain learns best.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
10. When evaluating students, I evaluate in a way that accounts for the fact that students learn differently.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
11. I pre-expose my students to content and context of a topic at least one week before introducing it.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always

12. I have attended worthwhile workshops or conferences which dealt with the topic of how students learn.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
13. I have sought the advice of colleagues concerning the implementation of a certain type of learning strategy.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
14. I support the use of real-life, immersion-style multi-path learning over traditional learning in my classroom.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
15. Our District has encouraged workshops, conferences, or in-service trainings on the topic of the newest strategies in classroom teaching.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
16. Different learning approaches are a waste of time in the K-12 setting.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree

17. The purpose in my classroom is to create a supportive, challenging, and complex environment where questions are encouraged.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
18. I view how students will learn best more important than what I should teach.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
19. I feel that how one learns plays an important role in classroom learning.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
20. I would be more willing to initiate various learning strategies if there were more time to do so.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
21. Brain-based learning is a fad in education which will pass as many other so-called “reforms” have done.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree

22. I believe I already do brain-based learning in my classroom.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
23. I would be more willing to initiate brain-based learning if I knew more about it.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
24. Brain-based learning is a very positive way to learn.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
25. I feel all K-12 teachers should know how to implement brain-based learning.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
26. It is not important to practice various learning strategies in my classroom.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
27. I should teach all my students the meaning and purpose of various styles of learning.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

28. I have been successful; therefore, I will not change my teaching strategy.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

29. I am willing to change my teaching style.

- ☐ 1 Never
- ☐ 2 Rarely
- ☐ 3 Occasionally
- ☐ 4 Often
- ☐ 5 Always

30. I utilize some form of brain-based learning strategy (e.g. students: drawings, charts, lists, dialogues, actions, demonstrations, debates, or maps) on a weekly basis.

- ☐ 1 Never
- ☐ 2 Rarely
- ☐ 3 Occasionally
- ☐ 4 Often
- ☐ 5 Always

31. I use new and updated information in all my education classes.

- ☐ 1 Never
- ☐ 2 Rarely
- ☐ 3 Occasionally
- ☐ 4 Often
- ☐ 5 Always

32. It is important to demonstrate and show educators new ways of teaching.

- ☐ 1 Never

- ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
33. I use the newest technology in my classroom
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
34. I currently attend educational conferences and workshops about the latest trends in education.
- ☐ 1 Never
 - ☐ 2 Rarely
 - ☐ 3 Occasionally
 - ☐ 4 Often
 - ☐ 5 Always
35. I feel the need to be more adequately trained in relaxation, movement, and crossing the midline activities and strategies to enhance learning.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
36. I view movement, relaxation, and cross-lateral stretching a valid form of readiness for learning.
- ☐ 1 Strongly Disagree
 - ☐ 2 Disagree
 - ☐ 3 Neither Disagree nor Agree
 - ☐ 4 Agree
 - ☐ 5 Strongly Agree
37. I feel that movement, relaxation, and cross lateral stretching should play an important role in classroom learning.
- ☐ 1 Strongly Disagree

- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

38. I feel that drinking water is a very important aspect that enhances learning.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

39. I use or encourage some form of movement in my classroom to help with focus, attention, or learning readiness.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

40. I encourage my students to use some form of cross lateral movements or crossing the midline for concentration or thinking skills.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

41. I have attended workshops or in-services which dealt with the topic of relaxation, movement, and crossing the midline activities and strategies for my classroom to enhance learning.

- ☐ 1 Strongly Disagree
- ☐ 2 Disagree
- ☐ 3 Neither Disagree nor Agree
- ☐ 4 Agree
- ☐ 5 Strongly Agree

APPENDIX B

OPERATIONAL DEFINITIONS OF VARIABLES

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Gender (G)	The sexual orientation or the sex of a person (boy/girl or male/female)	Item 01 (G01) What is your gender? ▪ Male ▪ Female	☐ Male = 0 ☐ Female = 1
Age	Demographic variable	Item 02. What is your age?	☐ younger than 30 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 or older
Current teacher	Used to verify eligibility for participation in study.	Item 03 Are you a current public-school teacher? (Not on any type of leave, including; medical, personal, educational, disciplinary, sabbatical, etc...)	☐ Yes ☐ No
Years of Teaching Experience (YTE)	The number of full-time years of teaching a teacher has professionally attained since his/her tenure began	Item 04 = YTE04 Respondent will answer the question: How many years of teaching experience do you have? By supplying their answer in the box.	1 = Less than 5 years 2 = 5-10 years 3 = 11-15 years 4 = 6-20 years 5 = more than 20 years
Grade level taught	Used to verify grade level for data analysis	Item 05. What grade level do you primarily teach?	☐ Elementary (K-5) ☐ Middle Grades (6-8) ☐ High School (9- 12)

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Teacher Knowledge (TKBBL)	A sense of teachers' cognitive awareness gained over years of educational training and personal experiences in the form of factual, conceptual, procedural and metacognitive. Such knowledge accrues from different learning settings, including content or subject matter knowledge acquired during training, pedagogical knowledge acquired from annual professional workshops and experience peers, and practical teaching skill acquired during years of teaching, assessment, and classroom management	<p>Respondent will answer items 06 to 15 where Item 06 = TKBBL06 Item 07 = TKBBL07 Item 08 = TKBBL08 Item 09 = TKBBL09R Item 10 = TKBBL10 Item 11 = TKBBL11 Item 12 = TKBBL12 Item 13 = TKBBL13 Item 14 = TKBBL14 Item 15 = TKBBL15 Item 35 = TKBBL35 Item 39 = TKBBL39 Item 40 = TKBBL40 Item 41 = TKBBL41</p> <p>Total score will be determined by summing answers to items 06-15 for a minimum score of 14 and maximum of 70 exact interval scale</p>	<p>Scale for items 6 – 10, 35, 39-41 is a 5-point Likert scale of 1 to 5; where,</p> <p>☐ 1 = Strongly Disagree ☐ 2 = Disagree ☐ 3 = Neither Agree or Disagree ☐ 4 = Agree ☐ 5 = Strongly Agree</p> <p>Scale for items 11- 15 is a 5-point Likert scale of 1 – 5; where,</p> <p>☐ 1 = Never ☐ 2 = Rarely ☐ 3 = Occasionally ☐ 4 = Often ☐ 5 = Always</p>
Teacher's Perception (TP1BBL)	A view or feeling or belief about brain-based learning as an effective strategy for teaching and learning that can promote teachers' willingness to initiate brain-based learning practices in the classroom	<p>Respondent will answer items 16 to 25, where</p> <p>Item 16 = TP1BBL16R Item 17 = TP1BBL17 Item 18 = TP1BBL18 Item 19 = TP1BBL19 Item 20 = TP1BBL20 Item 21 = TP1BBL21R Item 22 = TP1BBL22 Item 23 = TP1BBL23 Item 24 = TP1BBL24 Item 25 = TP1BBL25 Item 36 = TP1BBL36 Item 37 = TP1BBL37 Item 38 = TP1BBL38</p> <p>Total score is determined by summing answers to item 16 - 25 for a minimum score of 13 and maximum score of 65 exact interval scale</p>	<p>Scale for items 16 - 25 and 36 - 38 is a 5-point Likert scale of 1 to 5; where,</p> <p>☐ 1 = Strongly Disagree ☐ 2 = Disagree ☐ 3 = Neither Agree or Disagree ☐ 4 = Agree ☐ 5 = Strongly Agree</p>

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Teacher Practice of Brain-based Learning (TP2BBL)	<p>Constitutes how willing and frequent a teacher utilize or implement indicators of brain-based learning in their classroom.</p> <p>Such indicators include changing their teaching adopt a brain-friendly teaching style, attending professional development enhancement programs, and brain adaptable technologies in the classroom.</p>	<p>Respondent will answer items 26 to 34 where</p> <p>Item 26 = TP2BBL26R Item 27 = TP2BBL27 Item 28 = TP2BBL28R Item 29 = TP2BBL29 Item 30 = TP2BBL30 Item 31 = TP2BBL31 Item 32 = TP2BBL32 Item 33 = TP2BBL33 Item 34 = TP2BBL34</p> <p>Total score is determined by summing answers to item 26 - 34 for a minimum score of 9 and maximum score of 45 exact interval scale</p>	<p>Scale for 26-28 will be a 5 Likert scale of 1 to 5; where,</p> <p>☐ 1 = Strongly Disagree ☐ 2 = Disagree ☐ 3 = Neither Agree or Disagree ☐ 4 = Agree ☐ 5 = Strongly Agree</p> <p>Scale for item 29-34 is a 5 Likert scale of 1 to 5; where,</p> <p>☐ 1 = Never ☐ 2 = Rarely ☐ 3 = Occasionally ☐ 4 = Often ☐ 5 = Always</p>

APPENDIX C

IRB APPROVAL LETTER

September 14, 2018
Emmanuel Oduro-Bediako
Tel. 269-213-1739
Email: odrobed@yahoo.com

RE: APPLICATION FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS
IRB Protocol #:18-106 **Application Type:** Original **Dept.:** Teaching, Learning & Curriculum

Review Category: Exempt **Action Taken:** Approved **Advisor:** Elvin Gabriel

Title: Teachers' Knowledge, Gender, Perception and Years of Teaching Experience as Predictors of their Implementation of Brain-based Learning Practices in the United States.

Your IRB application for approval of research involving human subjects entitled: "Teachers' Knowledge, Gender, Perception and Years of Teaching Experience as Predictors of their Implementation of Brain-based Learning Practices in the United States" IRB protocol # 18-106 has been evaluated and determined Exempt from IRB review under regulation CFR 46.101 (b) (2). You may now proceed with your research.

Please note that any future changes (see IRB Handbook pages 12) made to the study design and/or informed consent form require prior approval from the IRB before such changes can be implemented. In case you need to make changes please use the attached report form.

While there appears to be no more than minimum risks with your study, should an incidence occur that results in a research-related adverse reaction and/or physical injury, (see IRB Handbook pages 18-19 this must be reported immediately in writing to the IRB. Any research-related physical injury must also be reported immediately to the University Physician, Dr. Katherine, by calling (269) 473-2222.

We ask that you reference the protocol number in any future correspondence regarding this study for easy retrieval of information.

Best wishes in your research.

Sincerely,

Mordekai Ongo
Research Integrity and Compliance Officer
Institutional Review Board – 8488 E Campus Circle Dr Room 234 - Berrien Springs, MI 49104-

0355

Tel: (269) 471-6361 E-mail: irb@andrews.edu

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