Examining the Impact of Brain-Based Professional Development on EFL Novice Teachers' Pedagogical Perceptions and Practices

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Abstract

This research investigated the impact of Brain-Based Professional Development (BBPD), which utilizes theories and key findings from educational neuroscience, on shifting EFL novice teachers' pedagogical perceptions and practices. A mixed-methods research design was utilized to allow triangulation of data and explore the multi-dimensional nature of teachers' perceptions. The participants included nine novice teachers of English language enrolled in the professional diploma of curricula and methods of teaching at the Faculty of Education, Port Said University. They were tested before and after the brain-based treatment that aimed at educating teachers about brain-based learning and brain-compatible instructional practices. Teachers were encouraged to transfer the knowledge gained from the BBPD by creating brain-compatible lesson plans and developing training sessions. The instruments included two adopted questionnaires, interviews, lesson plans, and training session templates. Results emphasized the significance of BBPD in shifting EFL novice teachers' pedagogical perceptions to be more brain-compatible and student-centered. Additionally, the teachers managed to develop lesson plans that are substantiated by brain research by incorporating the principles of Brain-Based Learning (BBL) and elements of Brain-Compatible Teaching (BCT) into their lesson plans. These changes in lesson planning demonstrated efficient understanding of BBL. Besides, educational implications for successful brain-compatible pedagogy and effective EFL teachers' preparation and training programs were provided. Orchestrated efforts from the Ministry of Education (MOE), curriculum developers, teacher educators, and EFL teachers of the English language are recommended.

Keywords: Brain-Based Learning, Brain-Compatible Teaching, Professional Development, EFL Teachers' Pedagogical Perceptions, Pedagogical practices, EFL Novice Teachers, 21st Century Learners

Introduction

21st century witnessed a rise of a new paradigm shift in teaching and learning. Bolstad et al. (2012) asserted that future-oriented learning and teaching underpins a shift in the meaning of knowledge and a need for a rigorous knowledge about learning; as the traditional forms of knowledge are no longer adequate for the challenges and demands in the 21st century. This paradigm shift from the instruction paradigm to the learning paradigm has, in turn, significant implications for teacher education. Scardamalia and Bereiter (2006) assured

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that teachers are required to adopt a knowledge building pedagogy that shifts from '*knowledge about*', which dominates traditional educational practices, to '*knowledge of*' by allowing students to work with authentic problems that result in deep and meaningful learning. To put this paradigm shift in practice, teachers need to know creative pedagogy and innovative teaching and learning methods to employ. Zhukova (2017) highlighted that to meet the 21st-century demands and challenges, 21st-century teachers are required to transform their pedagogical beliefs about the nature of teaching and learning and practices. There is a need for a shift from the traditional transmission approach to the 21st century non-directive teaching and learning approach. Hence, professional training needs to focus on the use of innovative student-centered teaching methods, techniques, and approaches.

Attaining the aims of 21st-century education requires developing teachers' knowledge, attitudes, and beliefs about the learner, learning, and teaching as well as reinforcing them with innovative instructional techniques that satisfy their students' needs. Neuroeducation allows educators to create a conducive learning environment that provides the students with the optimal possibilities of success in learning. Brain-based approach is deemed to be a new paradigm for 21st-century learning and teaching that provides teachers with the knowledge about how the brain operates and learns. Carew and Magsamen (2010) and El-Henawy (2018) agree that neuroscientific knowledge should be integrated into 21st-century teacher preparation and professional development. Such knowledge can inspire teachers to utilize various techniques to improve EFL instruction by engaging students in meaningful and authentic tasks.

The developed scanning technologies for brain imaging provided educators with various techniques for mapping brain functions and amazing knowledge about how the brain learns and processes information. To clarify briefly, Connell (2005), Hanson (2007), and Sousa (2017) noted some facts about the brain structure and function as follows. The brain has two types of cells: nerve cells (*neurons*) and *glial* cells. The glial cells protect the neurons and transport nutrients. The neurons are responsible for learning as they can receive, coordinate, analyze, and transmit information. The neuron has thousands of branches emerging from its core, called *dendrites* which receive electrical signals from other neurons and transmit them along the *axon.* There is a very small gap called a *synapse* between each dendrite and axon that collects signals from its neighboring neurons through the dendrites. Learning happens when it stores new information and the synapses make changes and influences neurons connections. Learning occurs when neurotransmitter activities enable the axon of one neuron to transmit information to the receiving dendrites of another. The brain's cells, as stated by Sousa (2016), grow and connect to store information and skills. These connections result in the development of neural networks that help the individual successfully manage the demands and challenges of life. Neural plasticity, one of the core aspects of brain operation, refers to the brain's ability to continually reorganize itself based on input, learn, and adapt throughout life. The brain is fueled with oxygen and glucose so eating healthy food, drinking water, and exercising can enhance the performance and accuracy of memory, attention, and motor function.

In the context of language learning and teaching, Sousa (2011) contends that the quality of teaching is the most influential factor affecting a student's learning, therefore English language learning (ELL) teachers need to be adequately trained for efficiently addressing the learning challenges that ELLs face. Furthermore, he outlines some neuroscience substantiated considerations regarding how successfully ELL students could acquire English as follows:

- A child's native language proficiency has a direct positive relationship to the acquisition of another language because the child has built robust language networks and a rich mental lexicon that can increase the likelihood of positive transfer during L2 acquisition.
- Learning a second language should start at very early childhood (preschool) as the child's brain has much more plasticity and children's innate ability to learn language decreases as they get older.
- The brain holds two separate stores for semantics, one for verbal information and the other for visual information. Thus language teachers should use concrete images for presenting an abstract concept.
- Learning any language at any age begins by listening to it for some time. After the brain becomes familiar with the new language's phonology, grammar, and syntax, the learner may attempt to speak it.
- Speaking a language regularly for several years during early childhood has a lasting benefit for retaining both grammar and phonology of the L1 for future use.
- The more frequently the irregular verb is used, the more likely the child will remember it.
- The more and children are exposed to oral language in the early years, the more quickly they can distinguish between phonemes and discover the rules of grammar that affect the meaning.
- L2 students who are motivated and have a positive attitude toward the target language and culture are more likely to be successful than those whose feelings toward the L2 culture are negative or fearful.
- Teachers should give ELLs a chance to practice conversational English with native English peers in social and non-academic situations.

Accordingly, EFL teachers, even for older learners, could benefit from these insights by ensuring native language linguistic proficiency and maximizing learning the additional language by providing opportunities for authentic and collaborative learning in relaxed environments that stimulate learner's motivation to practice language regularly and construct multicultural competencies. An active and intrinsically motivated older learner can master a foreign language more successfully than a less eager young learner. Brain plasticity is a core principle of educational neuroscience that could meaningfully contribute to learning additional languages as it indicates that the brain is amenable to change. Brain plasticity could reinforce teachers' growth mindsets that would affect their efforts as a life-long professional learner and as a motivating teacher who believes in effort not in fixed intelligence. Zadina (2015), an educational cognitive neuroscientist, assures that findings from neuroscience could revolutionize education. Educational neuroscience research on language learning indicated the

importance of early dual language learning as it gives an advantage for later language learning, reading skill, achievement, general cognition, working memory, and brain health. Additionally, she points that having appropriate knowledge of basic neuroscience research on learning is a crucial aspect of teacher education as such knowledge can inform teachers' instructional practices and promote their abilities to plan and implement more effective lessons.

The new requirements of the 21st century cannot be addressed with traditional methods. Benade (2017) assures that the challenging demands of 21st-century learning that are associated with pedagogical shifts require teachers to reconsider the learners' and teachers' roles, become more reflective about their pedagogical practices, reevaluate their knowledge and beliefs about the learner and the learning process, and adopt innovative teaching techniques. Being a teacher in the 21st century entails having self-conscious dispositions, such as openness to practice differently, being willing to challenge oneself and tensions of continually developing pedagogy, being responsive to the diverse needs of learners, seeking opportunities to design learning experiences that consider the learners' needs and interests.

Because of a lack of experience and sometimes inadequate preparation, novice EFL teachers rely on their initial perceptions and beliefs, acquired from their university preparation, to teach during the initial years of the profession. Zhukova (2017) pinpoints that most teachers tend to adopt the pedagogical practices that they experienced previously as learners and also those that were imposed by the traditional school system or the policymakers. Enhancing poor teaching, as Hativa (2002) suggests, demands addressing teachers' characteristics and aptitudes, pedagogical knowledge, and beliefs regarding instruction and learners. Teachers' perceptions of their students are important for effective teaching as effective teachers tend to employ techniques that match their perceptions of students' learning. Richardson (1996) points out that teacher's perceptions and beliefs are important in learning to teach as they influence what and how teachers learn and be able to do. She pointed out that there three sources for teacher's beliefs: personal experiences, experiences with schooling and instruction, and experiences with formal knowledge. In the context ELL, Lombardi (2008) mentioned that educating English language teachers about brain-based research would help them turn English language learners' problems into possibilities. Viewing ELLs through the lens of educational neuroscience gives new insights to educators about the adaptive nature of the brain. The brain, as the organ responsible for learning, can be tapped into, taught, stimulated, and grown through implementing various strategies that address the needs of diverse English language learners. Thus, an important step in improving EFL teaching is to improve their pedagogical perceptions and boost the relationship between such beliefs and practices.

Accordingly, without upgrading teachers' preparation and training programs, teachers may not be able to achieve the targeted shift toward brain-compatible pedagogy and attain the requirements of 21st-century education. Therefore, the present research introduces brain-based professional development (BBPD) to educate teachers about educational neuroscience and introduce brain-compatible instructional strategies. Additionally, teachers are encouraged to

transfer the knowledge and skills gained from the BBPD to new teaching situations and create unique lesson plans and training sessions. Specifically, this research aimed at examining the extent to which a year-long professional development altered novice English language teachers' perceptions of students' learning process and their instructional practices.

Context of the problem

As neuroscience is incorporated into programs for developing brain compatible classrooms based on brain-based learning strategies, the need for adequate professional development has emerged. However, many professional development initiatives failed to equip teachers with sufficient and updated knowledge about research-validated interventions and to engage them with practical activities for classroom implementation. For instance, Tilton (2011) discovered that receiving additional training about brain-based teaching intervention within a 2-day continuing education course had no significant effect on the participants' outcomes compared to the control groups that received the same course about facilitative instruction without this additional brain-based teaching part. Likewise, Radin (2009) found that teachers who did not have formal training in brain-based learning techniques cannot implement effective brain-compatible instruction, although they believed in the significance of brain-based learning techniques.

In the Egyptian context, teachers' professional development is provided officially by the Professional Academy for Teachers (PAT) under the supervision of the Ministry of Education (MOE). However, Professional Development (PD) used to be limited to training workshops for 3 days at most except the Teacher First Program initiated three years before. The Teachers First is a professional development program that allows educators to share experiences and learn from each other as they work collaboratively in communities of practice. Unfortunately, the PD provided by PAT targets only teachers employed officially in governmental schools. Accordingly, beginning teachers and all teachers who serve in private or independent schools are deprived of this service. There are nearly 18 non-governmental schools in Port-Said governorate, with an approximate population of 603,787 (2010). Besides, the government policy decreases employing teachers officially in public schools as it stopped mandatory recruitment into teaching for graduates of faculties of education (Taklif: تكليف) for serving in public schools twenty years ago. This policy imposes a competitive condition for graduates as they have to empower themselves with advanced skills to get a job opportunity of these limited positions in private schools.

Therefore, novice teachers and those who seek professional development and want to achieve job satisfaction join post-graduate studies at faculties of education to satisfy their professional needs. The Faculty of Education at Port Said University provides six professional diploma programs including Educational management, Child education, Educational and Psychological measurement, School psychologist, Special education, and Methods of teaching (different school subjects). Hence, the teachers enrolled in the professional diploma of Methods of teaching have selected it on purpose, inspired by their desire to learn new strategies that would promote their teaching practices and accordingly would enhance their students' academic performance.

The researcher was motivated and inspired to conduct this research due to the problems encountered by novice teachers of the English language and their professional needs to update their knowledge and enhance their teaching practices. This requires modifying teachers' pedagogical perceptions about learning and teaching and developing their competence utilizing a recent trend in education that is brain-compatible instruction. Carew and Magsamen (2010) elucidate the need for formal professional development training to ensure that all teachers attained practical knowledge and strategies to implement brain-compatible teaching based on neuroscientific research. Therefore, the researcher conducted this research to provide validated information that supports the incorporation of brain-based concepts into professional development programs to provide novice English teachers with the knowledge, beliefs, and skills needed to construct a productive learning environment that keeps up with the changes and requirements of 21st century. More specifically, the following questions were used to address the problem and purpose of this research.

1. How is BBPD effective in shifting EFL novice teachers' pedagogical perceptions?

2. How were EFL novice teachers' pedagogical perceptions following BBPD transformed into practice (in this research planning brain-compatible lessons and designing brain-based training sessions)?

Hypotheses of the research

Based on the discussion of literature and related studies and to answer the questions of the research, the following main hypothesis was derived '*There is a statistically significant difference between the mean ranks of the participating teachers' scores on the pre and post-assessment of their pedagogical perceptions*'.

To verify this hypothesis, the following sub-hypotheses were investigated:

a. There is a statistically significant difference between the mean ranks of the participants' scores on the pre-application and those on the post-application of Klinek's Modified Questionnaire.
b. There is a statistically significant difference between the mean ranks of the participants' scores on the pre-application and those on the post-application of Hassan's Modified Questionnaire.

Purpose of the research

The present research intended to:

1. Investigate the impact of BBPD on novice EFL teachers' pedagogical perceptions.
2. Examine how novice EFL teachers' pedagogical perceptions about BBL are transformed into practice (in this research planning brain-compatible lessons and designing brain-based training sessions).
3. Investigate EFL teachers' willingness to implement BBL in their classes, and the ease or difficulty in implementing brain-based principles.

4. Identify the aspects of BBPD that enhance the desired shifts of EFL teachers' perceptions.

Significance of the research

The significance of the current research stems from the following considerations:

1. Introducing brain-based learning as an innovative approach that can be used in English instruction.
2. Directing the attention to the necessity of integrating neuroscience knowledge into teacher education either pre-service preparation or in-service training.
3. Providing EFL teachers with an opportunity to transfer the BBL knowledge and skills acquired during their training into the learning environment
4. Providing guidelines upon which further brain-based treatments may be used to develop English language teaching.
5. Drawing the attention of educators in developing brain-based interventions for English language learners.
6. Adding value to scholarly literature with implications for EFL teacher preparation programs and professional development.
7. Inform teachers about how to develop brain-compatible learning environments.

Delimitations of the research

The present research was delimited to the following:

1. A sample of nine novice EFL teachers enrolled in a professional diploma at Port Said Faculty of Education.
2. Self-reported questionnaires for assessing EFL teachers' perceptions.
3. Assessing teachers' perceptions and planning practices not actual performance in classrooms.

Definition of terms

The following definitions establish the context for the terms used in this research.

Brain-Based Professional Development (BBPD)

Brain-based education refers to the "engagement of strategies based on principles derived from an understanding of the brain" (Jensen 2008, p. 4). Caine and Caine (1991, p.4) state that "brain-based learning involves acknowledging the brain's rules for meaningful learning and organizing teaching with those rules in mind". El-Henawy (2020, p. 130) defines BBL as "a new paradigm that acknowledges the neuroscience rules to achieve meaningful learning in accordance with the way the brain is naturally designed to learn". Jensen (2007, p.5) defines brain-compatible teaching as "an interdisciplinary approach that uses strategies based on the principles of how the brain works in a school context". El-Henawy (2020, p. 130) defines BCT as "a comprehensive approach of teaching grounded in cognitive neuroscience research that is concerned with adopting instructional and assessment practices

besides constructing learning environments that consider the brain structure and function". The present research adopts the definitions of BBL and BCT as conceptualized El-Henawy (2020).

Professional development is conceptualized by Hendriks, Luyten, Scheerens, Sleegers, and Steen (2010, p. 19) as "a set of systematic activities to prepare teachers for their job, including initial training, induction courses, in-service training, and continuous professional development within school settings". Darling-Hammond, Hyler, Gardner (2017, p. 2) define effective professional development as "a group of experiences that may result in professional learning and changes to teacher knowledge and practices, and improvements in student learning outcomes".

These views of brain-based education and teachers' professional development inform the definition of Brain-Based Professional Development (BBPD) in this research to be defined as the processes and activities, such as workshops; active peer-teaching lectures; reflective writing; reading and writing book reviews; and outlining some related research, that utilized brain-based approach to improve English language novice teachers' pedagogical perceptions and practices.

Teachers' Pedagogical Perceptions and Practices

Anderson (2009, p. 2) defines pedagogy as "the professional knowledge of the teacher about nature of learning, source of knowledge, and the role of the teacher, and the enacted practice of teaching, set within the context of theories of human development and learning, cultural reproduction and transformation, political and social progress, and intellectual engagement". Murphy (2008, p. 35) defines pedagogy as "the art of managing the interactions between teachers, students, the learning environment, and learning tasks". Peel (2017, p. 37) defines pedagogy as a "repertoire of theoretically aligned skills associated with learning and teaching that are supported by professional knowledge and that are contextually influenced to design curriculum, to select instructional strategies and to exercise management techniques within supportive learning communities".

Loughran (2008, p. 1180) defines pedagogy in teacher education as "knowledge of teaching about teaching and a knowledge of learning about teaching and how the two influence one another in the pedagogic episodes that teacher educators create to offer students of teaching experiences that might inform their developing views of practice". Pedagogy, as Loughran, Berry, and Mulhall (2012) pointed out, involves more than a package of teaching techniques. "Pedagogy entails creating dynamic links between teaching and learning attained by teachers' practices to adopt, adapt, and adjust the conditions for learning". Alexander (2008, p. 3) highlighted that "pedagogy encompasses the performance of teaching and its discourse including the theories, beliefs, policies that shape it". According to Siraj-Blatchford, Silva, Muttock, Gilden, and Bell (2002, p. 28), pedagogy refers to "the interactive process between the teacher, the learner, and the learning environment using a set of instructional techniques and strategies to enable learning to occur and create opportunities for obtaining knowledge, skills, attitudes, and dispositions within a particular social and material context".

Richardson (2003, p. 2) defines beliefs as "psychologically held understandings, premises, or propositions about the world that are felt to be true". Khader (2012, p.74) defines teachers' beliefs as "a set of ideas rooted in the psychological and mental content of the teacher and play a central role in guiding his/her teaching behavior". Maingi (2015, p. 28) defines perception as "a set of an individual's mental ideas about something that includes knowledge, beliefs, opinions, understanding, preferences, and views". The present researcher conceptualized pedagogical perceptions as teachers' knowledge, beliefs, and views about learning and teaching.

Besides, developing teachers' pedagogical practices is crucial to enhancing the quality of education. Pedagogical practices describe teachers' didactic practices before, during, and after teaching. Resh and Kramarski (2007) illustrate that pedagogical practices comprise three interrelated components: (1) planning, (2) classroom instruction, and (3) student's evaluation. Pedagogical planning reflects teachers' didactical objectives and approaches. The present research focuses on the first element of pedagogical practices which is teachers' planning. Van Es and Koper (2006) point out that lesson plans describe how learners can reach a learning objective or set of learning objectives. A typical lesson plan contains an introduction to the problem of the lesson, activities learners and teachers must carry out, learners' roles, learners' grouping, materials or technology to be used, and some evaluation guidelines.

These views of pedagogy and teachers' perceptions and practices inform the definition of teachers' pedagogical perceptions and practices in this research. Perceptions about learning include knowledge and beliefs regarding the nature of knowledge, effective approaches to learning, the outcomes of the learning process, and regulating learning. Perceptions about teaching include knowledge and beliefs regarding teacher's role and duties, subject matter, curriculum, instructional strategies, managing classroom and students' behaviors, and assessment. In the present research, teachers' pedagogical perceptions and practices refer to EFL novice teachers' knowledge and beliefs about the principles and strategies of EFL teaching and learning, particularly about brain-based pedagogy including knowledge and beliefs about BBL and BCT, and the extent to which BBL principles and BCT elements and strategies were manifested in the teachers' lesson plans.

REVIEW OF LITERATURE

Brain-based learning and teaching

Educational Neuroscience, which incorporates neuroscience, psychology, and pedagogy, provides a better understanding of the brain which is the main organ responsible for learning and offers a new framework for thinking about the learning process and the learner as well as the teaching process and the teacher's roles. "Learning is a process of building neural networks" (Wolfe, 2001, p. 135), and "teaching is the art of creating conditions that lead to nurturing change in a learner's brain" (Zull, 2002, p. 5). Brain-based learning (BBL) represents a new paradigm that acknowledges and translates neuroscience research for educational applications that assist educators to fulfill meaningful learning and manage teaching by moving from traditional teaching to the test to leading up purposeful

changes to better prepare students for the 21st century (Caine and Caine 1991; Cercone, 2006; Ronis, 2007). BBL is defined by Jensen (2008, p. 4) as "learning in accordance with the way the brain is naturally designed to learn". Accordingly, as stated by Connell (2005), teaching should focus on making connections with the students and helping them connect to academic content and develop the neural connections in their brains.

Teaching without understanding how the brain learns and processes information could be a daunting work. Schunk (2012) highlighted that neuroscience research provides teachers with insights about the complexities of cognitive processes such as attention, information processing, memory, and critical periods of development. Brain research suggests ways to make educational materials and instruction compatible with how students process information and learn. Caine and Caine (1991) proposed a set of 12 principles of BBL as a framework that connects neuroscience and education. Such principles provide teachers with valuable knowledge of brain functioning to maximize learning opportunities and optimize learning environments.

1. *The human brain is a parallel processor*, implying that the brain can do many things at one time. Therefore, teaching must orchestrate a vast repertoire of methods.

2. *Learning engages the entire physiology*, implying that the brain is a physiological organ functioning according to physiological conditions (e.g. stress, nutrition, exercise, and health) that affects our capacity to learn.

3. *The search for meaning is innate*, implying that making sense of every experience is inborn. The human brain is always hungry for novelty, discovery, and challenge.

4. *The search for meaning occurs through patterning*, implying that the brain learns by perceiving and generating meaningful organization and categorization of information.

5. *Emotions are critical to patterning*, implying that emotions facilitate the storage and recall of information.

6. *The brain simultaneously processes parts and wholes*, implying that the two brain hemispheres work interactively to makes sense of experience by perceiving both the big picture and the individual parts.

7. *Learning involves both focused attention and peripheral attention*, implying that as attention is important to learning, the brain can also learn from the context that is not consciously attended to.

8. *Learning involves conscious and unconscious processes*, implying that much of what the brain learns lies beneath the surface and it occurs through reflection, metacognitive questioning, and application of learning.

9. *There are at least two types of memory systems*, spatial instant memory and rote long-term memory. The spatial instant memory does not need memorization while rote memory stores relatively unrelated information that needs practice and

rehearsal. This implies the importance of immersing learners in experiences that engage multiple ways to remember.

10. *The brain understands and remembers best when facts and skills are embedded in natural spatial memory*, implying that embedding and immersing the learner in real and complex experience invokes the spatial memory and maximize learning.

11. *Learning is enhanced by challenge and inhibited by threat*, implying that the brain is sensitive to stress as it learns better under challenge and downshifts under threat.

12. *Every brain is unique*, implying that learning something new helps the brain grow and changes the structure of the brain by building new neural pathways, dendrites, and connections, hence the more one learns the more unique his/her brain becomes.

Caine, Caine, McClintic, and Klimek (2005) grouped the 12 principles of BBL into three interrelated elements of brain-compatible teaching (see figure 1.) as follows:

1. Relaxed Alertness: Creating the Optimal Emotional Climate for Learning

The optimal condition for learning to occur requires pushing the students beyond their comfort zone with challenge in a safe and caring learning environment. Perceived threat and stress in the learning environment causes downshifting and minimizes the brain capabilities. Teachers can create a state of relaxed alertness, consisting of low threat and high challenge, by (a) lowering threat and promoting self-efficacy; (b) promoting collaboration and interaction; (c) engaging students' curiosity for meaning-making; and (d) facilitating constructing emotional connections.

2. Orchestrated Immersion in Complex Experience: Creating Optimal Opportunities for Learning

Orchestration refers to providing are concrete and physical experiences that stimulate learners to interact with knowledge and is aligned with students' developmental stages and prior knowledge. Exposing the brain to multisensory meaningful experiences in enriched environments stimulates neurons to grow dendritic branches and form neural networks where thoughts and memories are stored. Teachers can create a state of immersion by (a) engaging both brain hemispheres to establish a balance between generality and specificity; (b) engaging the entire physiology in learning with multisensory and authentic experiences; (c) fostering the learner's capacity to make patterns and meaningful organization of information; and (d) acknowledging developmental steps in learning.

3. Active Processing of Experience: Creating Optimal Ways to Consolidate Learning

Active Processing refers to continuous consolidation that broadens and sustains knowledge and encourages students to internalize what they learn in a variety of ways to assure long-term retention. Teachers can create a state of active processing by (a) engaging both sensory memory and working memory; (b) promoting both focused attention and peripheral perception; (c) reinforcing both conscious and unconscious processing; (d)

considering learners' styles and uniqueness, (e) developing choice activities that allow students to choose how they process and store new knowledge.

Figure 1. Brain-Compatible Teaching (Adapted from Caine et al., 2005, p. 4)

Considering the principles of BBL, Jensen (2005) presented a three-stage teaching model encompassing nine educational processes that are substantiated by brain research to optimize learning. The first stage concerns what to do before any class begins and focuses on the preparation time that increases the potentials of instructional success. It involves two processes; prepare and create. The middle stage focuses on the bulk of the learning process. It involves five processes; engage, frame, acquire, elaborate, and connect. The last stages help ensure the learning is effectively capitalized. Table (1) illustrates Jensen's brain-compatible teaching model with some supporting classroom practices.

Table 1. Brain-Compatible Teaching Model

Stage	Process	Practices
Before 10%	PREPARE. Prepare yourself, Prepare your learners Pre-exposure to familiarize	• Plan well ahead of time to ensure success. • Use new keywords in discussions (pointing them out), or post them before the scheduled learning. • Introduce incidental material such as works of art, names of famous people, or related music or events. • Display key concepts in a wall poster. • Show a video well in advance of a topic.
	CREATE an optimal environment. Personalize the learning environment	• Promote feelings of safety. • Incorporate kinesthetics. • Monitor room temperature. • Monitor visual environment and lighting. • Monitor acoustics.
During 80%	ENGAGE Engage the mind and body Get learners involved emotionally and physically	• Create a positive social climate. • Use novelty to increase recall and students' involvement by creating situations for discovery and by excitingly providing information. • Use journaling, humor, affirmations, art, group rituals, activities, or stretching. • Incorporate activities that include all senses to reach each learner. • Teach more difficult content in the morning and allow more social interaction later.
	FRAME Hook the learner mentally and emotionally Make learning content meaningful for the students	• Trigger curiosity and wonder (through a picture, a story, or a background activity). • Connect information to real-life situations.
	ACQUIRE knowledge, skills, values, and experiences.	• Organize authentic and collaborative activities that offer the ideal opportunity for learning. • Orchestrate an activity, an experience, a field trip, a guest speaker, or a simulation. • Generate emotional connections to leaning.
	ELABORATE Ensure an accurate understanding of the material Deepen learning through integration, error correction, and active processing.	• Encourage students to form mental or physical models about their learning. • Correct misconceptions using error-correction strategies (e.g. partner quizzes, checklists, peer editing, presentations with feedback, and competitions).
	CONNECT Strengthening memory by relating learning to other content, processes, and self.	• Encapsulate the learning in an easy-to-recall format using drama, sharing with a partner, or testing mental models. • Use of acronyms, student-developed visual

		representations, partner reviews, quizzes, or rhymes
After 10%	SETTLE Too much, too fast, it won't last.	• Give time for passive processing of learning (e.g. breaks, walks, or lunch, or a reflecting task just before the end of class)
	REHEARSE (Revise & Review) Memories will get distorted if they are not used.	• Students summarize their learning in a paragraph, then pair-share. • Have students create a written quiz. • Ask students to create a mind map and pass it around for additions from others.

Jensen (2008) refined his model and provided the seven stages of brain-compatible lesson planning.

1. Pre-exposure: It provides the brain with an overview of the new learning before diving in. Pre-exposing learners to new material in advance helps the brain develop better conceptualization. Alert students' attention to new material to engage their brains in inquiring about it. The more prior knowledge learners have, the greater number of connections they'll make.

2. Preparation: It stimulates students to learn by creating curiosity and gives learners a real-world motive. Discovering students' prior knowledge in the subject helps teachers customize their planning to students' experience level and preferred learning style. Balance novelty and predictability. Consider students' characteristics when choosing learning materials and presentation strategies.

3. Initiation and Acquisition: It attains the immersion by providing an initial overload of ideas and details followed by curiosity and determination to discover and construct meaning. Acquisition happens both formally and informally so teachers need to provide learning experiences that reflect real life. Teachers should design a supportive and challenging classroom environment that prompts inquiry.

4. Elaboration: It involves learners in processing the learning content. It requires learners to think authentically to internalize learning. Learners need to think interdisciplinary to construct connections by relating the new learning of a subject to real life and other subjects. It is preferred to be acted cooperatively.

5. Incubation and Memory Encoding: It asserts the value of reviewing as the brain learns most effectively over time. Teachers should reinforce learners to encode learning in their memory with appropriate use of downtime, emotions, real-life associations, and mnemonic techniques.

6. Verification and Confidence Check: It allows learners to confirm their learning for themselves. Engage students with projects to demonstrate learning, reflective activities about what they've learned, and self-assessment and peer assessment activities to check and solidify what they have learned.

7. Celebration and Integration: It instills the love of learning as it engages emotions and allows students to have fun and celebrate their success. Functional integration happens only over time and with repeated reviews. Integrate new learning in future lessons.

Hardiman (2012) presented the Brain-Targeted Teaching Model (BTT) as a pedagogical framework for translating neuroscience findings into educational practices to help students develop 21st-century skills. BTT encompasses six core targets to support teachers in incorporating neuroscientific knowledge in designing, implementing, and evaluating teaching. The six brain targets include the following:

1. *Establish an emotional connection to learning.* Neuroscience research assured the influence of emotional arousal, both positive and negative, on attention, memory, and higher-order thinking. Teachers should create positive learning environments that reduce the negative effects of stress by establishing personal connections with students, provide clear expectations for academic performance, creating opportunities for reducing competition and encouraging collaboration, allowing reasonable choices in how students demonstrate learning, and using humor to help reduce stress.

2. *Develop the physical learning environment.* Elements of the physical environment such as novelty, changing seating arrangements, and classroom displays can affect students' attention and engagement in learning tasks. Teachers can optimize the learning environments by providing optimal lighting—that resembles natural light, creating novelty by changing seating arrangements, varying modes of course materials presentation, and monitoring the use of technology.

3. *Design the learning experience.* Teachers should design learning experiences that engage various senses, combine students' prior knowledge with new knowledge to create patterns of thinking and learning. Teachers can establish these connections by displaying the major content themes and their relationships using graphic organizers, engaging students in real-world applications of knowledge, and encouraging learners to draw their concept maps when they study to depict the relationship among concepts.

4. *Teach for the mastery of content, skills, and concepts.* Learning content, skills, and concepts requires that students retain information and use it meaningfully. To increase mastery—successful acquisition and long-term retention—teachers need to employ activities that enhance memory such as rehearsal, elaboration, and quizzes. Teachers can engage students in creating graphic designs, songs, works of visual art, and films.

5. *Teach for extension and application of knowledge.* Teaching and learning in 21st-century classrooms must not only lead to acquisition and mastery learning but also must boost using the practicable knowledge in authentic problem-solving tasks that require critical and creative thinking.

6. *Evaluate learning.* Continuous evaluation can enhance learning and memory so teachers need to expand traditional types of assessments to include using alternative assessments such as posters, presentations, portfolios, and projects. Additionally, standards

and expectations for performance should be announced to students in advance. Also, teachers should give timely and instructive feedback on students' assignments.

Table 2. Brain-Compatible Instructional Strategies

Brain-Compatible Instructional Strategies	
1. Brainstorming/Discussion	11. Manipulatives/Experiments Labs/Models
2. Drawing/Artwork	12. Graphic Organizers/Semantic Maps/Word Webs
3. Field Trips	13. Music/Rhythm/Rhyme/Rap
4. Games	14. Project/Problem-based Instruction
5. Humor	15. Cooperative Learning / Reciprocal Teaching
6. Metaphors/Analogies/Similes	16. Role Plays/Drama Pantomimes/Charades
7. Mnemonic Devices	17. Storytelling
8. Movement	18. Visualization/Guided Imagery
9. Technology	19. Visuals
10. Writing/Journals	20. Work-Study/Apprenticeships

In tandem with the previous brain-friendly educational models, teachers need to employ some instructional strategies that appeal to students' assumed brain preferences. Tate (2016) highlighted 20 instructional strategies that engage the brain actively (see Table 2). These strategies increase academic engagement and achievement, decrease behavior problems, and make teaching and learning fun. In the context of ELL, Lombardi (2008) pointed out that as learning new language skills represent a high challenge for students, ELL teachers should consider the neurodevelopmental constructs and take advantage of neuroscientific research. ELL teachers should employ a variety of strategies in their classrooms, including providing a welcoming and nonthreatening environment, tapping prior knowledge, designing cooperative-learning activities that allow learners to practice the language in social situations. In the ELL classroom, students need to be motivated to participate in various interactive activities such as reader's theater, pair-shares, kinesthetic activities and audiovisuals, rhythmic games, songs, oral rehearsal, manipulatives, and graphic organizers.

A review of related studies demonstrated that BCT was significant in promoting students' academic performance, retention of knowledge, and affective aspects concerning a variety of subjects across various educational stages including Social Studies for elementary students (Duman, 2006), Geography for developing critical thinking skill and attitudes of secondary students (Al-Edwan, & Al-Khawaldeh, 2016), and Philosophy for developing habits of mind and attitudes of secondary students (Abdel-Mageed, 2014); Mathematics for elementary students (Elsayed, 2015) and secondary students (Rehman, & Bokhari, 2011); Science for elementary students (Ozden, & Gultekin, 2008), middle school students (Akyurek, & Afacan, 2013), and secondary students (Uzezi, & Jonah, 2017); Arabic language teaching for developing creative writing of middle school students (Al-Shammari, & Al-

Hashemi, 2018), for developing linguistic creativity of secondary students (Mahmoud, Sayed, & Abu Nagi, 2016).

Reviewing previous studies in the context of ELL, it was found that BBL research mainly targeted developing vocabulary. Lago and Seepho (2012) found that brain-compatible activities improved the vocabulary learning and retention of Thai university students studying English for Tourism. Haghighi's findings (2013) indicated that BBL improved ESP academic achievement and retention of Iranian university students. Nafa (2013) found that the BBL had a significant effect on boosting L2 vocabulary attainment of EFL Emirati learners. Salem's findings (2017) revealed that BBL enhanced listening skills, vocabulary retention, and attitudes towards learning English of ESP Egyptian students.

Besides, a number of studies have examined the impact of BBL on boosting other aspects of ELL. Oghyanous (2017) indicated that adopting a BCT approach had positively affected the self-efficacy of Iranian EFL learners. Abu Sharekh (2018) found that using BBL strategies in teaching English reading comprehension was highly effective in developing higher-order thinking skills of 84 female 10th-grade Palestinian students. Likely, Bedeer (2018) found that using BBL strategies improved 5th-grade students' critical reading skills. Abd El-Maksoud (2016) found that BBL strategies (i.e. K.W.L, debates, and feedback strategies) were effective in developing journal writing of 47 English majors at the faculty of education, Beni-Suef University. Parnell (2018) found that BBL enhanced 2nd-grade Thai students English speaking abilities (task completion, comprehensibility, fluency, pronunciation, and grammar). Similarly, Khalil, El-Nagar, and Awad (2019) indicated that BBL promoted Egyptian secondary students' EFL speaking skills (i.e. accuracy, pragmatic, and fluency). The treatment encompassed various brain-compatible techniques including think-pair-share, brainstorming, discussion, graphic organizers (mind map and semantic map), role-paly, humor, authentic material (videos, reading aloud articles in international newspapers), music and movement.

Integrating neuroscience with pedagogy maximize possibilities for enhancing teaching and learning (Hardiman, 2001). For instance, acknowledging brain plasticity as one of the core neurobiological processes, entailing that the brain changes its structure as a consequence of experience and learning (Ansari, König, Leask, & Tokuhama-Espinosa, 2017), could significantly shift teacher's views on effective pedagogy, enlighten teachers about students behaviors, and equip teachers with a repertoire of instructional practices that would meaningfully contribute to meeting the needs of each particular student. Kiedinger (2011) found that training teachers on BBL positively affected their classroom practices and boosted their students' reading skills. Investigating the knowledge of BBL among postgraduate students (master and doctoral) majoring at Curricula and Teaching Methods Department, Yarmouk University, Malkawi and Alkhatib (2020) found that they have a low to medium level of knowledge. Accordingly, the researchers recommended incorporating BBL in teacher education programs and encouraging teaching staff to employ BBL in their courses.

Teachers' pedagogical perceptions and practices

Since teachers are the critical factor in the implementation of innovative and new instructional approaches, their pedagogical perceptions, attitudes, and beliefs get growing importance and interest. Pedagogy, as stated by Srinivasan (2016), is not a technical skill but a mixture of thinking and action compassing the relational values, the personal engagements, planning the content in response to a diverse classroom, choosing learning materials that fit the mental capabilities of students, engaging the class with meaningful activities, and assessing students' learning. Wang and Jensen (2013) point out that teachers' perceptions about teaching and learning have a robust impact on classroom practices and students' learning. Accordingly, considering and improving teachers' perceptions should be a vital element of developing effective teachers' development programs.

Though there is no agreed-upon definition of beliefs, there is a common scientific consensus that beliefs drive one's actions (Park, Lee, Oliver, & Cramond, 2006). Maingi (2015) describes perception as a sum of a person's general mental ideas concerning something that comprises knowledge, beliefs, preferences, and views. Silverman (2007) and Xu (2012) agree that teachers' beliefs and conceptions about learners represent an integral element of successful teaching as they affect how teachers approach teaching and manage classroom problems. Besides, efficient teachers have a growth mindset and they usually attribute student's learning problems to a wider realm, including teachers' practices, behaviors, and school environment not to constant deficits in the student that detracts from student success.

Research has shown that pedagogical perceptions direct how teachers plan for their classroom activities and frame the teachers' cognitions and behaviors in the classroom. Kramarski and Michalsky (2009) investigated pre-service teachers' perceptions of teaching and learning as an integral dimension of teachers' professional growth in addition to pedagogical knowledge and self-regulated learning (SRL) in pedagogical context. They elicited that teachers' perceptions of teaching and learning lie on a continuum of four major perceptions (transmitting information, modeling by the teacher, empowerment of the student, and self-construction of knowledge). Results indicated that integrating SRL with e-learning boosted pre-service teachers SRL skills and their pedagogical knowledge and shifted their perceptions to a more student-centered perceptions (self-construction of knowledge). Similarly, Chai (2010) and Lee, Zhang, Song, a Huang (2013) agree that teachers' pedagogical beliefs entail their views about knowledge transmission versus knowledge construction view which is reflected in the preferred ways of teaching. Teachers who adopt the knowledge transmission view incline to prepare and conduct lessons in a teacher-centered and content-oriented manner. In contrast, teachers who adopt the knowledge construction view scaffold their students through meaningful, situated, and authentic tasks to actively construct and internalize their learning.

In the implementation of any learning or teaching approach, including brain-based learning, the perceptions of teachers represent one of the most important influential factors. Researchers and educators agree that teachers' perceptions and beliefs help in interpreting

knowledge and experiences, mentor teachers' decision making, build their professional identity, and impact their instructional practices in the classroom and their professional learning (Pajares, 1992; Cheng, Chan, Tang, & Cheng, 2009; Denton, 2010; Galbat, & Sa'adi, 2018). Accordingly, shifting teachers' perceptions is important for teachers' development and educational reform. Choy, Wong, Chong, and Lim (2014) affirm that novice teachers are particularly in need to bridge the gap between pre-service teacher education and initial teaching experience by gaining effective knowledge of the context—students, curriculum, and school community. Caine and Caine (1998) point out that teacher professional improvement entails reflecting on their mental models or perceptions about learning and teaching. Mental models represent deeply held beliefs, assumptions, and images that affect their thinking and direct their actions. From this point of view, Wachob (2014) advocates that identifying teachers' perceptions of effective teaching strategies can help researchers identify the elements of research-based practices that still need to be translated. Systematic implementation of brain-based strategies, as highlighted by Caine and Caine (1995), challenge teachers to reflect on their mental models and change their conceptions of memory, assessment, the learning environment, the biology of the brain, and uses of time have all served to improve student achievement.

Reinforcing and deepening the development of teachers' pedagogical perceptions is considered to be a milestone in enhancing teachers' professional practices. Teachers' pedagogical practices, as stated by Resh and Kramarski (2007), include three interrelated components: (1) planning, (2) classroom instruction, and (3) student's evaluation. *Planning* relates to the assumptions and perceptions of teachers when preparing their class-work: materials, the pace of progress, and teaching methods. These perceptions could be content-oriented or learner-oriented. *Classroom instruction* relates to the techniques employed by teachers to communicate knowledge and manage students' learning. Innovative methods that get the students involved actively in the learning process and consider the students' daily experiences, as compared to conventional teacher-centered teaching. *Students' assessment* is a core element of teachers' pedagogical practices. Evaluating students' learning outcomes by grading needs to be enhanced with alternative techniques and tools of assessment that are authentic and focus on the actual performance.

Effective learning processes and successful teaching practices depend on rigorous pedagogical planning. Pedagogical planning reflects teachers' didactical reasoning processes involved in selecting appropriate methods, tools, learning activities, and assessments to suit the targeted learning objectives. König, Bremerich-Vos, Buchholtz, and Glutsch (2020) describe lesson planning as a problem-solving process involving making decisions based on teachers' dispositions, perceptions, and interpretations to address their students' needs. Planning encompasses setting learning objectives, considering appropriate teaching strategies to be implemented, considering assessing students' learning. In the context of TESL/TEFL, Pang (2016) pinpoints that planning and implementing instruction represent two decisive benchmarks for assessing teachers' knowledge, skills, and dispositions as evidence of quality teaching. Planning requires teachers to demonstrate an ability to plan for organizing and

managing ELL inducive classroom, and the instructional practices represent the ability to implement these lesson plans based on student interests and English proficiency levels.

Salminen and Annevirta (2016) assure that planning is an important phase of teaching because the decisions and choices teachers make when planning and teaching influence the learning of all pupils. When planning for teaching, a teacher interprets and converts the written curriculum through his/her pedagogical thinking to make it appropriate for teaching and learning. Teachers' pedagogical thinking, which includes their preparation, decision-making during teaching and theories, and beliefs, have a significant effect on how they act. Pang (2016) mentions that outcomes of teacher planning (i.e., unit or lesson plan) are commonly used as tools for assessing teachers as they can best reflect a teacher's competence in integrating theory and practice. However, studying this milestone pedagogical task of English language teacher seems scarce in language teacher research. Salminen and Annevirta (2016) investigated the extent to which the changes that were made to the Finnish curriculum in 2010 were manifested in teachers' pedagogical thinking when they were planning their teaching. The results indicated that pedagogical purposes of curriculum changes occur variously in teachers' pedagogical thinking when planning for teaching. These variations might be due to the different beliefs that influence teachers' pedagogical thinking. The researchers recommended strengthening teachers' planning skills to promote the teaching practice of the curriculum.

Effective professional development inspires educators to make shifts in how they think about their work and how they perceive what happens in class and accordingly act and respond to. Within Watt and Richardson's perspective (2008), beginning teachers' perceptions influence their subsequent pedagogical practices, professional engagement, development, and lead to different pathways of professional identity. Similarly, DiTullio (2018) highlighted that pre-service and novice teachers can be more impressionable and responsive compared to experienced teachers who can be more resistant to change as their beliefs become vigorous.

Teacher Professional development

Teacher professional development, as described by Guskey (2000), includes the intentional, ongoing, and systematic processes and activities devised to improve the professional knowledge, skills, and attitudes of teachers that might promote students' learning. Mizell (2010) mentioned that professional development includes educational experiences related to one's work to learn and apply new knowledge and skills that will improve their performance on the job. Such PD could be provided either formally (e.g. a conference, seminar, or workshop, collaboratively as a work team, or a course at a college or university), or informally (e.g. discussions among work colleagues, independent reading and research, observations of a colleague's work, or other learning from a peer). Additionally, Richards and Farrell (2005) presented various approaches for approaches to professional development for language teachers such as workshops, self-monitoring, teacher support groups, journal writing, peer observation, teaching portfolios, analyzing critical incidents, case analysis, peer coaching, team teaching, and action research.

Guskey (2000) contends that effective PD should utilize a combination of several models to achieve professional growth. Bayar (2014) and Parsons et al. (2019) agree that effective teacher professional learning and development should be based on current research, match teachers' specific needs, offer strategies easily implemented into classroom, and be sustained over time allowing teachers to learn, internalize, and apply new instructional methods. Additionally, Darling-Hammond, Hyler, and Gardner (2017) pinpoint seven features of high-quality teacher professional development: (1) *Being content focused* by focusing on teaching strategies associated with specific curriculum content; (2) *Incorporating active learning* as active learning engages teachers with contextualized professional; (3) *Supporting collaboration* by allowing teachers to share ideas and collaborate in their learning; (4) *Using models of effective practice* by providing teachers with a clear vision of what best practices look like using models such as lesson plans, unit plans, sample student work, observations of peer teachers, and video or written cases of teaching; (5) *Providing coaching and expert support* that involve sharing expertise about content and evidence-based practices and focus on teachers' individual needs; (6) *Offering feedback and reflection* as both help teachers to thoughtfully move toward the expert visions of practice; and (7) *Being of sustained duration* to provide teachers with adequate time to learn, practice, implement, and reflect upon new strategies that facilitate changes in their practice.

High-quality teacher professional development can shift teachers' perceptions, decision-making processes, instructional practices, and accordingly improve instruction and learners' achievement. Therefore, providing teachers with sufficient knowledge about validated and research-based practices would motivate them and stimulate their enthusiasm for adopting such practices. Gatt (2009) proved that a 3-year in-school professional development program aiming at promoting Drama in a primary school with a low socioeconomic status was successful in improving the teachers' perceptions of drama conventions and the sustainable implementation of drama strategies in their classrooms. Buczynski and Hansen (2010) found that incorporating inquiry learning in professional development for 4–6th-grade science teachers was effective in improving the teachers' science content knowledge. Additionally, the teachers reported implementing inquiry practices in their classrooms and their students experienced modest gains on standardized science achievement exams. Similarly, Geduld's study (2017) demonstrated that the teachers who were more knowledgeable about self-regulated learning (SRL), were more positive about SRL and demonstrated more teaching behaviors that foster SRL among their students.

Several studies have proved the significance of adopting brain-based approach for teachers' development and students' learning and growth. Radin's study (2009) indicated that incorporating brain-based research into teacher education would reinforce reconceptualizing teaching to be in tune with how the brain learns. Roehrig, Michlin, Schmitt, MacNabb, and Dubinsky's study (2012) revealed that a sustained professional development program that combined neuroscience content with inquiry-based pedagogy reinforced teachers' successful implementation of inquiry-based practices and fostered progressive growth in their classes. Dubinsky, Roehrig, and Varma (2013) found that BrainU professional development program, which educated middle and high school teachers about neuroscience, was effective in

fostering more student-centered pedagogical practices and provided the teachers with neuroscience knowledge and a more growth mindset towards student's ability to grow and learn. The BrainU program encompassed 160-hour workshops over a 3-year period, with BrainU 101 spanning 2 weeks and BrainU 202 and 303 spanning a combined 2 weeks.

Additional support for the use of BBL was reported in a study conducted by Parr (2016) exploring teachers' awareness and knowledge of brain-based research implications for teaching and learning as well as changes in classroom pedagogy following the integration of Hardiman's model (2012) of Brain-targeted Teaching (BTT) in a 6-hour professional development session. The study collected data from 44 public school educators using self-reported tools including online surveys and semi-structured interviews. The study concluded three major results including (a) promoting awareness and knowledge of brain-based theory can guide instructional decisions, (b) integrating BTT strategies in professional development can result in increased implementation in the classroom, and (c) employing BBL and BBT concepts for teaching and learning can boost student engagement. In a similar study, Seegers (2020) examined the perceptions of 12 California community college faculty of the Brain-Targeted Teaching (BTT) following a six-session professional development. The study used online surveys and researcher observation during the six TL sessions to explore how the participants perceive the value of BTT and the changes in their pedagogy. The participants perceived the BTT as a valuable framework and they reported changes in their lessons, as well as their approach to whole courses or their overall views on students, teaching, and learning.

In light of evidence proliferation of the significance of infusing BBL in teachers' PD initiatives, Becker (2005) contends that neuroscientific knowledge should be integrated into teacher preparation programs and then boosted in follow-through training to assure that the learned neuroscientific concepts and practices are transferred into daily plans and classroom practices. From this point of view, educators (e.g. Hobson, Ashby, Malderez, and Tomlinson, 2009; Choy, Chong, Wong, and Wong, 20) advocate the initial and early professional learning of novice teachers as the first years of the teaching profession is the ''survival stage'' and is deemed a critical period for monitoring teachers' growth. Novice teachers face some common challenges such as inadequate knowledge of both the core content and their students' learning which may produce negative attitudes and conceptions of the teaching profession. Consistent with these claims, Choy, Wong, Lim, and Chong (2013) found in their three-year study that beginning teachers' pedagogical knowledge and skills continued to grow significantly in the first three years after finishing their initial teacher education program regarding lesson planning, classroom management, and instructional strategies.

According to the previously mentioned literature and related studies, some conclusions can be stated as follows:

- Few experimental studies tackled BBL in teaching the English language particularly in the Egyptian EFL context (e.g. Nafa, 2013; Oghyanous, 2017; Salem, 2017; Khalil, El-Nagar, & Awad, 2019).

- Some of the studies that mentioned BBL as the independent variable did not illustrate the features of the brain-based treatment or how the BBL principles and stages of BCT were implemented and some other studies limited it to using (3-5) strategies (e.g. Lago, & Seepho, 2012; Akyurek, & Afacan, 2013; Nafa, 2013; Abd El-Maksoud, 2016; Salem, 2017; Parnell, 2018). This might indicate deficient understanding and implementation of BBL as it is a comprehensive approach that requires not only diversifying the learning and teaching strategies but also requires considering motivational aspects, managing the learning environment, and refining assessment techniques and tools.

- There is still little knowledge regarding English language teachers' knowledge and beliefs of brain-based theory and how classroom practices reflect the principles of BBL. Exceptions include the findings of Hassan (2013) and Denton (2010) indicating that, to the best of the researcher's knowledge, no study has attempted to examine EFL Egyptian teachers' perceptions of BBL.

- There are few mixed-method studies on brain-based learning that focused on a deep and comprehensive examination of teachers' perceptions and beliefs concerning brain-based professional development. Most previous studies investigated teachers' perceptions about BBL using the quantitative approach (e.g. Klinek, 2009; Morris, 2010; Ridley, 2012; Wachob, 2012; & Hassan, 2013). As stated by DiTullio (2018), there are few qualitative studies on brain-based learning and there are even fewer studies regarding professional development models that could be useful in training educators in neuroscience.

- Some studies were descriptive investigating stated brain-based planning and instructional practices through self-reported tools such as interviews or questionnaires (e.g. Klinek, 2009; Morris, 2010; DiTullio, 2018) instead of analyzing and assessing performed and observed pedagogical practices (i.e. planning, instruction, or assessment) through checklists, rating scales, or rubrics.

- The literature of BBL and PD included studies conducted with different educational levels and in-service teachers, however, pre-service and novice teachers were underrepresented.

METHODOLOGY

Design of the research

A Mixed Methods Research (MMR) design was adopted for this research, which combines both quantitative and qualitative data collection and analysis to allow triangulation of data and explore the multi-dimensional nature of teachers' perceptions. The quantitative method was used to collect empirical data using a questionnaire and the qualitative method was used to gather rich and in-depth data through interviews and analyzing lesson plans. MMR is defined by Creswell and Plano Clark (2011) as a method that focuses on collecting, analyzing, and mixing quantitative and qualitative data in a single study or series of studies to provide a better understanding of research problems. MMR, as stated by Halcomb and Hickman (2015), provides significant opportunities for researchers to gain a deeper

conceptualization of complex issues than would be possible via the use of either quantitative or qualitative data. Although MMR design is complex as well as time, resources, and effort consuming, this design helped the researcher explore in greater detail how BBPD developed EFL teachers' perceptions about learning and teaching. The treatment was applied throughout the academic year 2018-2019.

Participants

The participants in this research were nine EFL novice teachers, eight females and one male. They enrolled in the professional diploma of curricula and methods of teaching at the Faculty of Education, Port Said University. They aged between 22 and 24 at the time of the research. They were fresh graduates with at most two years of teaching experience.

Data Collection

As the research involves a mixed-method research design, which draws on qualitative and quantitative research methods, data collection included two questionnaires for assessing teachers' perceptions, teacher interviews, and analyzing the lesson plans and the training sessions (available with the researcher upon request).

1. Teachers' questionnaires

Quantitative data were collected through questionnaires. The participating teachers were administered two questionnaires for assessing their knowledge and beliefs about brain-based learning (BBL) and brain-compatible teaching (BCT). Participants responded by using a 5-point Likert scale according to the following key: 1-Strongly Disagree, 2- Disagree, 3-Neutral, 4- Agree, and 5- Strongly Agree. Some of the items were reverse scaled to avoid agreement with a statement regardless of the question.

The first questionnaire was a slightly modified version of the Brain-Compatible Classroom Questionnaire (BCCQ), originally developed by Hassan (2013). Apart from the adaptation of the questionnaire from Klinek (2009), Hassan's questionnaire (2013) was structured based on the three interrelated fundamental elements in the 12 Brain-Based Learning Principles by Caine and Caine (1991) and Caine et al. (2005). The original questionnaire comprised three parts: (1) Knowledge about Learning, explored teachers' pedagogical beliefs about a brain-compatible classroom; (2) Demographics, inquired about the demographic factors of the respondents; (3) Classroom Practice, investigated teachers' classroom practices. For the purpose of the current research, only the first part of BCCQ was utilized. Hassan's questionnaire (2013) was to a great extent avoiding leading questions and tending to use short and familiar words to respondents as they are not English native speakers as well as in the present research.

Also, this researcher utilized a modified questionnaire Brain-Based Learning Questionnaire (BBLQ) which was based on the adaptation of famous questionnaires in brain-based education with established validity and reliability including Klinek (2009), Morris (2010), Ridley (2012) and Wachob (2012). It was preferred to use such a modified questionnaire as Ridley's (2012) and Wachob's (2012) were mainly constructed based on

Klinek's survey (2009) which was meant for educators at the higher level of education and some of the survey questions were on attitudes toward BBL and self-efficacy of using BCT. Morris' survey (2010) focused on the implementation of brain-based instructional practices rather than on perceptions. Ridley's questionnaire (2012) focused on beliefs/attitudes about brain-based learning and high-stakes testing. Statements that assess other aspects like attitude and self-efficacy were avoided as the researcher was mainly concerned with assessing teachers' knowledge and beliefs about BBL and BCT.

This researcher utilized items from the previously mentioned instruments due to established validity and reliability. The language of the statements of the questionnaires is consistent with the language and concepts used in the BBL principles to help achieve content validity. The validity was enhanced by the judgment of an expert panel, consisting of 3 English supervisors in the MOE and 2 educators in faculties of education, and administering a pilot instrument to a group of 16 English prospective teachers at Faculty of Education, Port Said University. Based on the pilot study, some items were paraphrased and some other items were eliminated. The Cronbach's alpha reliability coefficient for the BCCQ 36 items was (a = .949), suggesting that the items have a high level of internal consistency for the scale with this specific sample. The Cronbach's alpha reliability coefficient for the BBLQ 15 items was (a = .732), suggesting that the items have acceptable internal consistency for the scale with this specific sample.

2. Teacher Interviews

To further clarify how the perceptual changes occurred, the participants were interviewed on three occasions, at the beginning of the treatment, the end, and the follow-up stage. The purpose of these interviews was to exemplify and provide external validation for the perceptions expressed in the questionnaires. Participants were prompted to discuss their rationale, their experience as well as their pedagogical beliefs. The questions for the interviews in the research were decided after a review of the literature. The researcher piloted the interview protocols with other three English language teachers to check the clarity of the questions and detect the problematic parts of the interview process. The researcher also asked field experts and colleagues their views about the questions. After the piloting of the items, some questions were reworded, two questions were combined and two questions were omitted for redundancy. The final version of the semi-structured interview schedule included 8 questions.

Five teachers were interviewed individually and the other three teachers were interviewed as a group. It was found that individual interviewees were to some extent not feeling at ease. Therefore, the last three teachers were interviewed as a group. Each individual interview lasted approximately 15 minutes. Two months after the end of the treatment, follow-up interviews were conducted with only 4 teachers who were willing and free to participate in an online interview. The entry interview encompassed questions exploring teachers' perceptions in three areas: prior knowledge about BBL, perceptions about students' learning, perceptions about teaching practice. The guide of the exit and the follow-up interview contained additional questions about transforming their beliefs and knowledge into

practices. It was divided into two parts; the first part included three questions similar to those in the entry interview with additional questions to realize the change in the participants' responses concerning their perceptions about students' learning and teaching practices. The second part served to shed light on the participants' beliefs about incorporating BBL in their teaching and managing classrooms, willingness, and sense of efficacy of applying BBL in their classrooms. Furthermore, a question about the elements of the BBPD that mostly affect them and change their perspectives.

All interviews were audio-recorded using a cellphone. Verbatim transcriptions of interviews were then returned to the participants for verification. Data from the interviews were analyzed qualitatively and described according to the main interview questions.

3. Teacher Lesson Plans & Training Sessions

Furthermore, to examine how the conceptual changes that occurred as a result of the BBPD were translated into actual practices, teachers were encouraged to develop detailed lesson plans and training sessions. Four lesson plans and five training sessions were developed collaboratively except one of the teachers preferred to work individually. The lesson plans and the training sessions were analyzed to check the extent to which they are aligned to the principles and the three fundamentals of BBL.

The Treatment

In the present research, the treatment was divided into two phases following the three fundamental elements of brain-compatible teaching. *The first phase* aimed at presenting the theoretical information of BBL. This phase aimed at achieving two fundamental elements of BCT; (a) relaxed alertness by engaging the participating teachers' innate search for meaning and consolidating social interactions, (b) orchestrated immersion in complex experience by enhancing the participants' ability to perceive both details and the larger view and promoting the participants' capacity to recognize and master essential patterns. The participating teachers were encouraged to construct their knowledge about brain-based learning and brain-compatible teaching by getting them engaged in a variety of activities as follows

1. Workshops: Two workshops were implemented in the first academic term. *The first workshop* covered neuroscience content including the brain structure and function as well as the principles of BBL and its implications. *The second workshop* handled the fundamental elements of brain-compatible teaching, the seven stages of brain-based planning, and the commonly recommended brain-based instructional practices. Some of these practices were presented in active lectures separately.

2. Active lectures: These lectures were presented in both the first and the second academic term. They were presented unconventionally as some of them were led by the participants themselves. Additionally, the lectures were supported by discussions with participants and practical activities. The lectures covered a variety of brain-compatible techniques such as inquiry-based learning, situated learning, scaffolding, hands-on activities and manipulatives, drama techniques, metacognitive strategies, reciprocal teaching strategies, Imagine-Elaborate-Predict-Confirm (IEPC),

Collaborative Strategic Reading (CSR), peer-assisted learning, shared reading, Survey-Question-Read-Recite-Review (SQ4R), Preview-Question-Read-Reflect-Recite-Review (PQ3R), and Survey-Connect-Read-Outline-Look back (SCROL).

3. Reflective writing: The participants wrote reflectively about BBL after the three workshops and about some selected topics presented in the lectures.

4. Reading and writing book reviews: Each participant wrote book reviews of two books selected from five books. The books used for this task were Wolfe (2001) Brain matters: Translating research into classroom practice, Hanson (2008) Brain-friendly strategies for developing student writing skills, OECD (2007) Understanding the brain: The birth of a learning science, Connell (2005) Brain-based strategies to reach every learner, Erlauer (2003) The brain-compatible classroom: Using what we know about learning to improve teaching.

5. Outlining some related research: The participants were engaged in outlining three academic papers about BBL. Outlining tasks were done in pairs utilizing any of the previously studied reading strategies PQ4R, SQ3R, SCROL. The papers used for these tasks were Lago and Seepho (2012) Brain-compatible activities for EFL vocabulary learning and retention and Pattanapichet (2012) Brain-based Instructions: Bringing in Neuroscience to Foreign Language Teaching.

As for *the second phase*, after establishing a knowledge base, the participants were encouraged to transform their knowledge into application. This phase represents the active processing of experience to consolidate EFL novice teachers learning about BBL and expand their knowledge. They were engaged in a variety of activities as follows

6. Preparing brain-compatible lesson plans: They were aligned to the principles of BBL following the seven stages of brain-based planning. The lessons were planned cooperatively in pairs or small groups.

7. Developing training sessions: The teachers were free to choose the topics they handled in their sessions as they played the role of experts in different self-chosen fields including TEFL, Childhood education, Special education, Educational psychology, and Educational assessment.

RESULTS AND DISCUSSION

The results of the research will be presented in terms of the quantitative and qualitative indicators of development in novice English teachers' perceptions as revealed by the results of the research instruments.

Results of the questionnaires

The IBM SPSS statistical analysis software package 25.0 was utilized to analyze and tabulate the results of the questionnaire. The results of the research will be presented in terms of testing the research hypothesis; *there is a statistically significant difference between the mean ranks of the participating teachers' scores on the pre and post-assessment of their pedagogical perceptions*. To verify this hypothesis, the following sub-hypotheses were investigated:

a. There is a statistically significant difference between the mean ranks of the participants' scores on the pre-application and those on the post-application of Klinek's Modified Questionnaire.

The "Wilcoxon Signed Ranks Test" was used to find out the extent to which novice teachers' perceptions about BBL and BCT have developed after the treatment. A Wilcoxon Signed-Ranks Test indicated that the median posttest ranks, Mdn = 69, were statistically significantly higher than the median pre-test ranks, Mdn = 46, Z = -2.670, p-value = .008 < 0.05. The results of the "Wilcoxon Signed Ranks Test" proved to be statistically consistent with the above-stated hypothesis as shown in table (3).

Table 3. Z-value of the pre- and post- Klinek's Modified Questionnaire

Pre- Klinek's Modified Questionnaire		Post- Klinek's Modified Questionnaire		Z-test	
M.	S.D.	M.	S.D.	Z-value	Asymp.Sig.
48.000	4.472	62.333	10.440	-2.670	.008

The previous table reveals that there is a statistically significant difference between the subjects' mean scores of the pre- and post-application of the Klinek's Modified Questionnaire, in favor of the post-application. Thus the aforementioned hypothesis was accepted. Furthermore, an effect size was calculated as $r = \frac{z}{\sqrt{n}} = \frac{-2.670}{\sqrt{9}} = .089$ which is very large according to Cohen's classification of effect sizes which is 0.1 (small effect), 0.3 (moderate effect), and 0.5 and above (large effect).

b. There is a statistically significant difference between the mean ranks of the participants' scores on the pre-application and those on the post-application of Hassan's Modified Questionnaire.

The "Wilcoxon Signed Ranks Test" was used to find out the extent to which novice teachers' perceptions about BBL and BCT have developed after the treatment. A Wilcoxon Signed-Ranks Test indicated that the median posttest ranks, Mdn = 144, were statistically significantly higher than the median pre-test ranks, Mdn = 118, Z = -2.521, p-value = .012< 0.05. The results of the "Wilcoxon Signed Ranks Test" proved to be statistically consistent with the above-stated hypothesis as shown in table (4).

Table 4. Z-value of the pre- and post- Hassan's Modified Questionnaire

Pre- Hassan's Modified Questionnaire		Post- Hassan's Modified Questionnaire		Z-test	
M.	S.D.	M.	S.D.	Z-value	Asymp.Sig.
115.778	20.148	143.888	14.853	-2.521	.012

The previous table reveals that there is a statistically significant difference between the subjects' mean scores of the pre- and post-application of the Hassan's Modified Questionnaire, in favor of the post-application. Thus the aforementioned hypothesis was

accepted. Furthermore, an effect size was calculated as $r = \frac{z}{\sqrt{n}} = \frac{-2.521}{\sqrt{9}} = .084$ which is very large according to Cohen's classification of effect sizes.

Results of the interview

In order to add further validity to the findings, semi-structured interviews were developed to explore in-depth novice teachers' perceptions about brain-based learning and teaching. To get a better picture, a sample of the teachers' comments and responses is presented as illustration and evidence to complement the findings of this research.

The responses of English novice teachers in the entry interview were similar to a great extent and led to the same conclusions that they tend to use teacher-centered instruction in which students work individually most of the time with few opportunities for pair and group work in specific occasions. They mentioned a few examples of teaching strategies like brainstorming, discussion, and games. They were highly concerned with managing the time of the period and afraid of group work as it took time and affects classroom discipline. When they were asked about teaching strategies, they mentioned that they chose the strategy that suited the lesson and was easy to apply. When they were asked about learning processes and strategies, there was a kind of agreement that students learn by repetition and practice. Also, they only related learning strategies to students and gave a few examples including highlighting, summarizing, and outlining. Additionally, they were not able to specify the teachers' role in learning strategies. As for brain knowledge, in response to the question 'Did you have any prior knowledge before this year about BBL?' they had poor knowledge about the brain and how it works. They referred to a lesson they studied in the secondary school about the two halves of the brain, but interviewee Mo added that he taught a psychology chapter about phrenology as mentioned in the following interview excerpt

> *Interviewee Mo: Yes, I did. Okay, had some resources related to Psychology (A subject that I am teaching) it started with a chapter teaching students about phrenology and then while I made my research about the lesson I expanded in info to grasp more about how the brain functions and learns*

However, in the exit and the follow-up interviews, when the teachers were asked a similar question about BBL, 'Did you have prior experience related to BBL before the BBPD?' some of the responses are as follows:

> *Interviewee E: No, it was my first time to study such topics and by the way, now I know how value these topics are. The new British curriculum that I'm dealing with focused upon this.*

> *Interviewee Y: No, I wasn't familiar with the BBL topics before I enrolled in the diploma. Frankly speaking, it did widen my horizons a lot on how our brains are so complicated yet so fascinating.*

Interviewee Sh: No I didn't. But I found that before this year I used to use some of the brain-compatible practices though I did not know that they are related to the brain.

For more information about teachers' knowledge about BBL, they were asked 'What do you think are the most important principles of BBL? Why?' The growth of teacher's knowledge about BBL is demonstrated in comments like the ones below:

Interviewee Y: Learning is enhanced by challenge and inhibited by threat. If students feel that they are not in a safe environment, they will not feel free to make mistakes and they will never learn. So it is not about the grades. Students need to have fun as they learn so they will progress and grow.

Interviewee B: Learning is emotional. Using real experience and connecting them to the students' emotions and life has a great impact on learning and their ability to remember.

Interviewee N: Learning is connected to emotions as we should not punish our students but instead of that we should praise them and give them positive and constructive feedback. We should always encourage and motivate them.

Interviewee A: Search for meaning through patterning. That is why there is a need for using thinking maps and mind maps to help students categorize and organize information.

Interviewee Sh: Learning engages the whole physiology. The search for meaning is innate. The search for meaning comes through patterning. The brain processes wholes and parts simultaneously. Those what I do remember now. I like to create positive learning environments to encourage the students to use their all senses during learning. To connect their own prior knowledge with the new one. And as a teacher, I suppose to create a challenging environment for students to highly participate. I must put in my mind the curriculum I'm teaching and their own learning styles and how to teach them to construct their own knowledge.

Parallel to this change of knowledge about BBL, the teachers experienced changes in their perceptions about the learning process. They perceived that they need to (1) construct their own knowledge not just to acquire knowledge and memorize information, (2) be scaffolded and given opportunities to consolidate their learning, (3) be motivated and provided with a safe and encouraging classroom environment in which they are given constructive feedback. These perceptions were portrayed in the following responses:

Interviewee Mo: I used to believe that learning happens deliberately and consciously by acquiring knowledge but now I believe in the importance of peripheral perception for learning and memory and that some of the learning happens unconsciously for example once I asked my students to make a YouTube channel in which they present their work such as oral presentations, interview, acting. The aim of learning was not only to process the content and be creative but also to be self-learners.

Interviewee Y: After studying BBL, I discovered that there is of course at focused attention learning happens but there is also an unconscious process of learning. So students can learn other stuff while working in an activity. They can learn from peers and from the situation itself, it is a kind of unplanned and incidental learning.

Interviewee A: I used to think that students learn and acquire information by repetition and practice but now I know that students can learn by themselves and from each other using inductive methods and inquiry-based learning.

Interviewee N: Now I know that there are many factors that affect students' learning like their own feelings and the environment not only my performance as a teacher.

Furthermore, different patterns of change in teachers' perceptions were demonstrated when asked about the teaching process and their selection of teaching strategies. They referred to various instructional techniques like shared reading, peer-assisted learning, IEPC, hands-on activities, mind maps, thinking maps, debating, reciprocal teaching, field trips, brainstorming, drama techniques (e.g. role-play, storytelling, hot seating), situated learning, problem-solving, project-based learning, Think-Pair-Share, SQ4R, and PQ3R. The English novice teachers in this research realized the change, as evidenced in comments like the ones below:

Interviewee B: now I know many different teaching strategies and I can vary my use according to the situation and the different kinds of students like SQ4R and PQ3R. Also, I used to think that the teacher is the only one responsible for choosing teaching strategies and materials but now I believe that teachers should know about their students to be able to choose suitable techniques and students should participate in choosing and preparing the materials.

Interviewee E: l like most to use situated learning and scaffolding. It gives the students the opportunity to construct their own

knowledge. Situated learning achieves a concept related to BBL that learning is social. Also, I learned how to prepare a creative lesson plan using the seven stages of BBL.

Interviewee Y: I can use strategies that depend on imagination and give students the chance to find the meaning or the solution by themselves. IEPC, for example, allows students to imagine, think and elaborate on their own thinking.

Interviewee F: The best strategy for teaching is the one that considers the students.

The change in pedagogic beliefs and values was asserted by their response to the question 'How does studying BBL have affected your beliefs about teaching?' Some of the responses are as follows:

Interviewee N: I used to teach the whole class and then they work on tasks individually but now I know that students have different learning styles and I use different techniques to motivate them.

Interviewee E: BBL studies makes me feel that everything in the Ss curriculum is important and can benefit them throughout their life and that each bit of information has a purpose. It helps me to be more focused on my outcomes and to change the strategy if it is not suitable for my Ss abilities. In other words, I feel I become more flexible.

Interviewee Mo: Frankly, I think the ultimate goal of teaching is to teach the learners "How to learn". It is not going to be the abstract info in the books only, anymore! but beyond to what revolves about the info, its applications, usage, and structural creation.

Interviewee Y: Well it's not the same as before. My point of view has changed a great deal I now consider the Ss as delicate complex yet very special and productive part of the process. If they are fully aware of what we're doing and why and how to reach the target this will aid the teacher a lot. As for the strategies we apply they must vary according to the Ss needs and levels to give every child a chance to learn in the way the best suits him.

For more information about the change in pedagogic knowledge and beliefs of English novice teachers, they were asked about some elements (e.g. forms of assessment, movement, food, and water) supported by BBL and could affect their classroom practices and their students' learning as well. As for assessment, there was some similarity in their responses as they used formative and authentic assessment not only tests that focus on memorizing.

Alternative forms of assessment were mentioned like peer and self-assessment, portfolio, K-W-L, thinking maps, preparing a play, exit cards, journal writing, projects. Concerning movement, there was a great shift in their perceptions. The following interview excerpts illustrate how

Interviewee A: I did not use to allow movement in class as it could make noise and affects the students' attention. Now I think it is important. I can use relaxation exercise and cross-lateral activities or use movement as a response for questions so instead of answering yes or true they could make some movements like raising their hands or clapping.

Interviewee F: I used to think that movement should not be allowed in class as it is time for learning but now I know that students can make some movements during performing a task.

Interviewee Me: Movement is effective. I used to feel like interrupted and lose my focus when students make movements around the class but now I believe I should allow them to move according to tasks.

Interviewee B: I did not think that movement is necessary especially for kinds as I cannot control them but now I know that they can learn more by moving and playing.

Parallel to this shift in perceptions about assessment and movement, the teachers demonstrated changes in their perceptions about food and water. This perception was portrayed in the following interview excerpts

Interviewee Y: I thought that it is okay for young students up to grade 3 or 4 to have food in class but I did not think that it was that much effective. I thought they were hungry but now I think it is very necessary for them to have snack in-between activities.

Interviewee B: I used to think that there is no problem to drink or eat inside the class. Now I believe it is necessary to allow students to drink or eat.

Interviewee A: It was not allowed for my students to eat or drink in class but now they could eat or drink as it is very useful for their healthy brains to be ready to learn.

The second part of the interview focused on assessing the participants' perceptions about transforming their knowledge and beliefs into application. Table (5) presents their responses to the three questions about their ability to apply BBL. It demonstrated that the teachers become more confident in planning and performing brain-compatible lessons, but, at the same time, it would not be easy for them to share this knowledge and beliefs with other

teachers. This may be due to their need for more education about BBL and more opportunities for application of BCT as it is mentioned in responses of some teachers who elaborated on this part.

> *Interviewee E: Ok course I'm not fully aware or knowledgeable but the period that I studied it aids me in a proper way. I need to learn more for sure. I need to revise what I learned about BBL and search more to be able to apply it in the new school year especially because the curriculum supports that.*

> *Interviewee Y: On a scale of 1 to 10 I think I may be a 6 because I only applied it in the course I haven't tried it outside in real life but if I have the opportunity to apply BBL I will progress and do well.*

Table 5. The teachers' transformative beliefs about BBL

Interview questions (Part 2)	Responses		% of Highest rank
	1-5	6-10	
1. How do you perceive your level of expertise in applying BBL in your class?	3	6	66.6
2. Based on your experience with the BBL, how confident do you feel in writing brain-compatible lesson plans?	2	7	77.7
3. Based on your experience with the BBL, How confident do you feel in helping other teachers develop brain-compatible lesson plans?	4	5	55.5

Furthermore, the teachers were asked a question about the elements of the BBPD that most affect them and change their perspectives. It was found that the change in EFL novice teachers' perceptions about BBL is due to one or more of the BBPD activities practiced throughout the treatment. Through their journey of constructing their own knowledge about BBL, they participated in some individual and cooperative tasks including (1) book review, (2) attending workshops about BBL and participating in discussions, (3) outlining a research, (4) preparing lesson plans and preparing training sessions, and (5) performing a training session. Teachers were asked to answer the question 'Which one of the BBPD activities affects you the most?' and to rank these activities according to its impact. Analyzing the teachers' responses, it was found that they highly ranked practical activities that are practiced collaboratively such as participating in workshops about BBL, developing lesson plans and training sessions as well as presenting a training session for other teachers rather than individual and theoretical activities such as writing book reviews or outlining educational research. This perception was portrayed in the following interview excerpts of some teachers who elaborated on this question.

> *Interviewee Sh: For me practice is the most important thing but without practicing of course I'll forget the information that I know. And I wasn't interested in all the theoretical information. For me they are boring. I was excited to learn how to deal with*

different ages and to know new ways to use to teach and new activities and how to assess students in different ways.

Interviewee B: I think preparing training sessions and performing a training session affects the most because we worked much on them, revised them and make modifications according to the feedback and the more we think and make effort the more we learn.

Results of the lesson plans and the training sessions:

Analyzing the lesson plans provided by the teachers, it was found that they identified the seven stages of brain-compatible lesson planning proposed by Jensen (2008). All of them focused mainly on utilizing cooperative strategies such as discussion, brainstorming, think-pair-share, role-play, reciprocal teaching, and IEPC. Additionally, two lesson plans encouraged students to express their feelings about the content (living in town versus living in the countryside and healthy food versus fast food) which engages emotional connections. Engaging both social interactions and emotional connections help in creating the optimal emotional climate for learning named relaxed alertness.

Furthermore, lesson plans included different materials to engage students' physiology including pictures, realia (e.g. real crab, fast food and healthy food), models, videos, audio recordings, PowerPoint presentations. Also, three lessons used mind maps (e.g. a mind map of living in the countryside, a mind map of healthy food) and thinking maps (a circle map for marine animals) either prepared by the teachers or by the students in groups which enhance the learner's ability to perceive both details and the larger view and promote the learner's capacity to recognize and master essential patterns. These materials help in achieving orchestrated immersion in complex experience.

In reviewing lesson plans, it was clear that they sought active processing of experience to consolidate learning through various ways (e.g. group or pair discussion, games, paragraph writing, improvisation, oral presentation). Also, students were encouraged to make decisions by setting goals for learning and assessing themselves using K-W-L-H and peer assessment.

Besides, some other brain-compatible practices were incorporated into the lesson plans. One lesson plan celebrates students' success by publishing their video-recorded oral presentation and paragraphs on the online page of the school. The other three plans specified time for drinking water or juice and eating snacks or sweets as a kind of brain food. Three lesson plans encouraged students to move and stretch their bodies to refresh their minds. One of these plans engaged students in movement as a form of giving answers or peer feedback by raising hands or putting hands down.

The participating teachers were asked to develop training sessions for other teachers as a way of transforming their knowledge and beliefs about BBL. The training sessions covered various elements of English teaching and BBL (e.g. teaching English reading and vocabulary, using music, engaging memory, managing classroom environment, brain-compatible

assessment, teaching students with special needs, and differentiated instruction). However, these sessions incorporated the key aspects of BBL in a limited way. They presented some information either about the principles, the three fundamental elements of BBL, and the seven stages of lesson planning or about some brain-compatible practices without demonstrating the connection between each of these practices and the aspects of BBL. The training sessions demonstrated a minimal to partial expertise in transforming the participants' knowledge to other teachers.

DISCUSSION

The results can be interpreted in terms of the context of the treatment which had a significant impact on the participants' beliefs. More specifically, using BBL shifts the teachers' pedagogical perceptions from the transmission view of teaching which focuses on the content and the teacher to a more brain-compatible view focusing on the students and the learning process itself. As evident from the results, participating teachers posited that the teacher should scaffold students' learning, engage students' minds and senses with authentic and meaningful experiences, allow students to take part in planning and assessing their learning, and provide safe, encouraging, and enriched classroom environment. These findings are consistent with prior work of Dubinsky, Roehrig, and Varma (2013) and Walsh (2010) showing that enhancing teachers' awareness about the core concepts of neuroscience change their understanding of the learning processes and their students, resulting in altering some of the classroom control strategies and making them better teachers. Additionally, the findings are consistent with previous research about teachers' beliefs (e.g., Ridley, 2012; Wachob, 2012; Denton, 2010) asserting that teachers who are knowledgeable and have strong beliefs about brain-based learning are more willing to change their teaching practices to improve the learning process.

Moreover, perceptual shifts were found in the teachers' approach to learning as well as their approach to teaching. The teachers' beliefs about learning appeared to shift from knowledge acquisition through drill especially repetition to knowledge construction through collaborative, inquiry, and experiential learning. Moreover, the participants went further during the treatment in seeking autonomous learning and life-long learning skills. This significant change in the participants' perceptions was due to applying the professional development based on brain-based learning. The BBPD did not only inform the teachers about BBL and how to apply it in their classrooms but also followed the fundamental elements of BBL for managing the teachers' learning about BBL. Therefore, this research represents a model for how neuroscience knowledge can be integrated into the education of in-service English teachers.

Unlike previous correlational research that investigated teachers' perceptions related to BBL (e.g., Ridley, 2012; Wachob, 2012; Denton, 2010; Walsh, 2010; Klinek, 2009), the present research examined teachers' perceptions as a result of a year-long brain-based professional development. The program included both theoretical as well as practical activities. One of the most validated and research established professional development programs related to BBL is Dubinsky, Roehrig, and Varma's (2013) sustained "Brain U"

program which does not involve direct instruction of neuroscience concepts, but instead utilized inquiry-based approaches. Unlike the "Brain U" program, the present research utilized a mix of direct instruction represented in the workshops and some activities represented in reviewing books, outlining research, designing lesson plans and training sessions. The activities vary to cover both theoretical knowledge and applications of BBL. The integration between theory and practice was important for shifting EFL novice teachers' perceptions about learning and teaching to a more student-centered and brain-compatible approach. The results revealed that there was a positive impact of the brain-based professional development on the teachers' perceptions and subsequent implementation through the lesson plans and the training sessions. Nevertheless, EFL novice teachers were enthusiastic to know more about teaching rather than about learning. They were eager to study practical aspects of BBL and its implications rather than theoretical information about the structure of the brain and how it functions.

On the other hand, despite the aforementioned results, the implementation process encountered some difficulties stated in the following points:

• The brain-compatible lesson plans were supposed to be applied by the teachers in their classes and the training sessions were supposed to be presented for EFL teachers in the form of two-day workshops. The participating teachers were supposed to reflect on such experiences which would represent a kind of active processing of experience that consolidates their learning about BBL. However, due to the governor's decision to hasten the final examination three weeks in advance, the participants presented a training session for their peer teachers of other subjects enrolled in the professional diploma.

• Furthermore, the participating teachers encountered some difficulty with some activities including reflective writing, book reviewing, designing the training sessions, and outlining research as they did not encounter such activities before in their teacher preparation. In order to manage this problem, the teachers were provided with a reflection sheet template, an academic book review checklist, and a teacher training session template as a kind of scaffolding. As for the research outlining activity, the participants were encouraged to utilize reading-to-learn strategies such as PQ4R, SQ3R, and SCROL. They were supplied with outlining worksheets including power-notes, I-chart, frame outline, double-entry journal. The participants were encouraged to work creatively and be free to choose and use whatever the strategy and the outlining sheet they like to feel in control of their learning.

IMPLICATIONS AND RECOMMENDATIONS

The findings of the present research have numerous important pedagogical implications for teacher educators, teachers of the English language, the Ministry of Education (MOE), and curriculum developers. The most obvious pedagogical implication of the research is derived from the findings that brain-based professional development modifies English novice teachers' perceptions about the learning process, their students, and their roles as teachers leading to a change in their instructional planning practices from a knowledge transmissionist

view to a brain-compatible view. Additionally, the following recommendations for future professional development are suggested:

• Developing teacher PD initiatives that integrate theoretical knowledge with classroom practice. Teachers need to deepen and actively process the knowledge, gained from PD training about innovative and creative teaching methods, in real contexts.

• Developing transitional training that considers novice teachers' professional needs.

• Teacher PD needs to be well-orchestrated using various professional development models (e.g. action research, study group, self-directed activities, or monitoring).

• Training teacher educators on BBL and BCT and other innovative 21st century educational approaches. Being an educator of the teachers of tomorrow requires acknowledging and adopting innovative trends of teaching and learning. Teacher educators should consolidate teacher candidates' experience immersion to internalize theoretical knowledge by practical models. Atmaca (2016) assured that teacher educators could create a 'domino effect' on educational success by employing BBL activities in university courses for educating teacher candidates who, in turn, apply BBL in their future classes.

The obtained results could also provide implications for promoting effective teaching and meaningful learning by helping teachers and educators to better understand the nature of the brain and how it learns. The researcher offers some implications and recommendations as listed below:

• Activating students' prior knowledge stimulates neurological pathways and helps with patterning which is essential for the meaning-making process. To this end, teachers can use techniques that connect new information to prior knowledge such as brainstorming, K-W-L, think-pair-share, and pre-expose students to the content of learning utilizing organizers such as mind maps, thinking maps, and concept maps.

• Teachers need to vary teaching strategies according to their students' different learning profiles and styles. Multisensory practices, multiple intelligence activities, drama techniques, and learning centers would be effective for engaging students with diverse needs at the same time.

• Teachers should create a conducive learning environment that is safe, rich, and collaborative to help students optimize brain functioning (Caine et al., 2005; El-Henawy, 2018).

• Furthermore, assessment should be brain-compatible by adopting a balance of assessments that encompass testing along with classroom formative and authentic assessments (El-Henawy, 2017)

• Additionally, current over-stuffed English language curricula need a radical shift to adopt a brain-friendly approach. The Egyptian educational system needs to move from a system that generates stress and downshifting to a better one that elevates creativity among teachers and students. The quantity and the quality of English language curricula in Egypt need to be reconsidered. Curricula developers should modify the conventional curricula by incorporating authentic and meaningful problems, organizing simulation and multimodal

activities, providing sufficient time for learning, and supplying plenty of novelty and feedback. Chai (2010) affirms that to construct or to transmit knowledge is for the teachers a methodological choice informed by contextual constraints for achieving their goals. In the Egyptian context, EFL teachers are overwhelmed with the central demands of the MOE and they are forced to choose between innovative teaching practices and personal survival with a downshifted profession. The MOE needs to know that under threat either students or teachers cannot create. Parallel to this, participants of the current research referred to the congested timetable of curricula as the main constraint and a challenge for implementing BBL, except two of them who taught in international schools that apply American and British curricula. In this vein, this research recommends that the planners and developers of the English language learning curricula need to reduce and ease the content of the textbooks and course syllabi. English curricula should focus on learning to use the language, allowing more time for practice rather than learning about the language.

DIRECTIONS FOR FURTHER RESEARCH

Based on the present research, the researcher suggests the following areas for future research:

- Examining the effect of using BBL in educating early childhood and special education teachers.
- Investigating the impact of BCT on the English literacy development of young learners.
- Examining the effects of BCT on improving English language learning.
- Investigating the effect of BBL on developing 21st-century learning skills.
- Examining the effectiveness of infusing BBL with interventions for students with special needs.
- Studying the impact of PD on fostering teachers' transformational leadership as teachers are agents of change.

Since it was beyond the limits of a single research to consider a wide range of factors, this research has some limitations, which, in turn, provide some suggestions for further research. Such limitations include characteristics of the sample, data collection, and other aspects related to the treatment. All of these variables should be taken into account when evaluating the findings and may influence the generalizability of the findings. These limitations are explained in the following terms:

• A sample of nine novice EFL teachers at Port Said Faculty of Education participated as an experimental group. Lacking a control group and the small sample size of the current research decreased the generalizability of findings. Future research will be necessary to determine the effectiveness of BBPD with a larger and more diverse sample of novice and expert teachers. Besides, further research could also be conducted to explore the effects of incorporating neuroscience into pre-service teacher education.

- Investigating teachers' perceptions depends mainly on self-reported instruments including the two questionnaires and the interview. Developing a test to assess teachers' knowledge, vignettes to assess teachers' beliefs, or a rubric to evaluate the lesson plans might boost the validity and reliability of the research. Likewise, future research is needed to assess teachers' classroom implementation of BBL using videos and observation checklist.

- Aspects related to the treatment such as the duration and the content represent another limitation. As for the duration, though it extends throughout two academic terms with three phases of assessment (i.e. pre-treatment, post-treatment, and the follow-up), a three or four-year longitudinal study on student teachers could be conducted to explore in-depth the impact of BBL on novice teachers. Concerning the content, incorporating more neuroscientific information about the brain structure and function like those included in the "Brain U" program of Dubinsky et al. (2013) might promote teachers' knowledge and practices especially with themes like plasticity and memory.

CONCLUSION

Brain-based learning represents a new paradigm for 21st-century education. From a neuroscientific perspective, learning involves constructing and strengthening neural connections by activating prior knowledge, organization, rehearsal, elaboration, immersion, and emotional involvement in learning. Brain research suggests that instruction should appeal to students' assumed brain preferences. Neuroscientific knowledge empowers teachers with insights about the nature of learning and operations involved in memory and development. Additionally, it informs teachers about innovative ways of upgrading their teaching and enhancing their students' learning. Brain-compatible teaching strategies allow teachers to reach every learner by creating safe learning environments, connecting new knowledge to prior knowledge, and allowing time for practice and reflection to strengthen neural pathways. This research presented a brain-based professional development for novice EFL teachers and evaluated its impact on their perceptions about learning and teaching through questionnaires, interviews, and an analysis of teachers' lesson plans and training sessions. Results indicated that the teachers have sufficient knowledge of how the brain learns best and made significant pedagogical shifts to apply this knowledge by preparing lesson plans and training sessions aligned to the aspects of BBL. This research pinpointed that a brain-based approach can be incorporated into teacher education to enhance learning outcomes by shifting teachers' perceptions and practices from a teacher-centered transmissionist approach to a brain-compatible approach.

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دراسة أثر التنمية المهنية المستندة إلى الدماغ على التصورات والممارسات التربوية لدى معلمي اللغة الإنجليزية كلغة أجنبية المبتدئين

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المستخلص

هدف البحث إلى دراسة أثر التنمية المهنية القائمة على التعلم المستند إلى الدماغ في تغيير التصورات التربوية لدى معلمي اللغة الإنجليزية المبتدئين وتخطيط التدريس القائم على التعلم المستند إلى الدماغ. ضمت عينة البحث تسع معلمين مبتدئين لمادة اللغة الإنجليزية والمسجلين بالدبلوم المهني في المناهج وطرق التدريس بكلية التربية جامعة بورسعيد. تم استخدام منهج البحوث المختلطة والتي تجمع بين الأساليب الكمية والكيفية في جمع ومعالجة البيانات والتي اعتمدت على استبيانان لقياس تصورات معلمي اللغة الإنجليزية حول التعلم والتدريس القائم على الدماغ، ثلاث مقابلات، وتحليل خطط الدروس وجلسات التدريب المستندة إلى الدماغ التي تم اعدادها من قبل عينة الدراسة. كشفت نتائج البحث عن فاعلية المعالجة التجريبية في تغيير التصورات التربوية لعينة البحث بشكل إيجابي، بالإضافة إلى تنمية قدرتهم على تحويل هذه التصورات لممارسات فعلية من خلال تصميم خطط دروس ونقل هذه الخبرة لغيرهم من المعلمين من خلال تصميم جلسات تدريب . انتهت الدراسة إلى بعض التوصيات ومنها ضرورة تضمين التعلم المستند إلى الدماغ في برامج اعداد المعلم وتنميته مهنيًا.

الكلمات المفتاحية : التعلم المستند إلى الدماغ، التدريس المتوافق مع الدماغ، التنمية المهنية، معلمي اللغة الإنجليزية المبتدئين ، التصورات التربوية، الممارسات التربوية