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An Investigation of the Compatibility between Fourth-Grade EFL Textbook Content and Teachers' Practices in Light of Brain-Based Vocabulary Instruction: A Case Study of Selected Primary Schools in Tizi-Ouzou

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Dedication

This work is dedicated to all those who supported me throughout this journey:

To my beloved mother, who stood by me from the very beginning to the final moment.

To my father, whose guidance and unwavering support lit my path.

And to my siblings, whose presence and emotional support carried me through, with a special place in my heart for Assia.

Fatiha Abri

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Abstract

Foreign language learning involves the brain's natural capacity to receive, process, and form new neural connections, and understanding how this intricate human organ functions helps explain the way learners acquire and retain language effectively. In this regard, the present study investigates the extent to which the fourth-grade Algerian EFL textbook and teachers' instructional practices align with the BBL approach. It seeks three main objectives: First, to examine how vocabulary components are presented in the textbook through the lens of BBL principles. Second, to explore how teachers approach vocabulary instruction in light of BBL principles. Third, to determine the degree of compatibility between the textbook and teachers' practices in terms of brain-based vocabulary instruction. The study is grounded in the theoretical framework of BBL elements and principles as outlined by Caine, Caine, Klimek, and McClintic (2009). It adopts a qualitative research design, with data collected through textbook analysis and semi-structured teacher interviews and analyzed using qualitative content analysis. The findings reveal a nuanced alignment between the textbook and classroom practices in relation to Brain-Based Vocabulary Instruction. Both sources reflect aspects of the three core BBL elements: relaxed alertness, immersion in complex experiences, and active processing, either through overlapping techniques or through distinct but complementary strategies. However, gaps have also been identified, with certain BBL aspects being insufficiently addressed by one or both sources. The study concludes with pedagogical implications for educators, textbook designers, and policymakers, highlighting the need to bridge these gaps for more effective BBL implementation. Overall, brain-based learning is present in both sources, but in varying and incomplete ways.

Key words: Brain-Based Learning, fourth-grade EFL learners, instructional elements of Brain- Based Learning, textbook analysis, teachers' practices, vocabulary teaching.

List of Abbreviations

- **AI:** Artificial Intelligence
- **BBA:** Brain Based Approach
- **BBL:** Brain Based Learning
- **CBT:** Cognitive Behavioral Therapy
- **CNS:** Central Nervous System
- **EFL:** English as a Foreign Language
- **NLA:** Natural Language Approach
- **PNS:** Peripheral Nervous System
- **QCA:** Qualitative Content Analysis
- **TPR:** Total Physical Response

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Statement of the Problem

In the realm of education, English holds the status of a global lingua franca. Accordingly, Algeria, like many countries, recognizes its importance by integrating it into its statutory curriculum. For decades, English has been compulsorily taught as a foreign language in Algerian middle and secondary schools, as well as in higher education. Importantly, the Ministry of National Education officially introduced it at the elementary level in September 2022. This recent introduction of English teaching to young learners is not arbitrary; rather, it is supported by studies that have shown the benefits of early language learning. As Marcos (1997, p. 5) notes, acquiring a second or foreign language during childhood is linked to both brain development and linguistic growth.

With respect to EFL instruction in Algerian primary schools, educators have begun to lay the foundation for the fundamental aspects of language, among which vocabulary is a key component. As Krashen and Terrell (1983, p. 155, as cited in Zimmerman, 1997, p. 15) suggest, without vocabulary comprehension, acquisition cannot take place. In fact, while vocabulary is undeniably important, it is one of the most challenging aspects of teaching children. This is evident in a recent study by Chenna (2023), which reports that young EFL learners struggle to develop their lexical knowledge, facing difficulties in understanding, memorization, and pronunciation. To address this challenge, scholars have proposed various educational theories, such as Krashen (1989), Lewis (1992), and Nation (2001). Among these, the brain-based learning approach (1991), which leverages findings from neuroscience research to align with how the brain naturally processes and retains information, is widely recommended for its role in enhancing vocabulary teaching process, especially for children.

At the national level, different studies have examined the way EFL vocabulary is taught and learned in Algerian EFL classrooms. One such study by Menasra and Elaihar (2023) examined vocabulary teaching strategies in the third-year "*My Book of English"* textbook used

in Ain Temouchent primary schools. It analyzed the vocabulary teaching strategies embedded the third-year textbook. The findings have revealed that while the material serves as a significant source with exercises and images, it relies heavily on direct word learning, with limited integration of independent learning methods. Accordingly, the study made some recommendations, such as careful selection of vocabulary to enhance the instruction.

Another work entitled *"Investigating the Techniques English Teachers Use to Enhance Vocabulary Acquisition in Primary School Pupils in Tizi-Ouzou"* was conducted by Laidani and Laidaoui (2023) from the University of Mouloud Mammeri of Tizi Ouzou. Among its objectives, the study has sought to describe the tools used by English teachers to introduce new vocabulary to young learners. Drawing on Mayer's cognitive theory of multimedia learning (2009), it has been found that the instructional methods employed are mainly flashcards, realia, conversations, and stories, alongside other teaching aids. Yet, it also highlighted challenges, including limited teaching materials and lack of motivation among pupils, which may hinder vocabulary learning.

Both studies have offered insightful conclusions and pedagogical suggestions that can enhance vocabulary instruction in EFL primary schools; however, they are limited in scope, particularly as research on primary schools is still scarce. Indeed, the question of how EFL textbooks and classroom practices align with the principles of Brain-Based Learning remains underexplored. Therefore, the present research aims to bridge this gap from a neuroscience-informed perspective.

Aims and Significance of the Study

The overall aim of this dissertation is to investigate the compatibility between the fourth-grade EFL textbook and teachers' practices in selected primary schools in Tizi-Ouzou, with regard to brain-based vocabulary instruction. To that end, the study pursues three main objectives. First, to examine how vocabulary components are presented in the textbook through

the lens of BBL principles. Second, to explore how teachers approach vocabulary instruction in light of BBL principles. Third, to determine the degree of compatibility between the textbook and teachers' practices in terms of brain-based vocabulary instruction.

This study makes a significant contribution to the field of language teaching, particularly English as a foreign language (EFL), offering a valuable contribution to the field of EFL vocabulary instruction. It informs classroom teachers, textbook designers, and policymakers about the effectiveness of techniques used to teach vocabulary by examining whether they correspond to the brain-compatible teaching principles. Additionally, this research will help the reader gain an understanding of the importance of targeting the brain in learning. Accordingly, curriculum developers and educators may revise the instructional practices and materials to adopt brain-based techniques that meet the needs of 21st-century classes when teaching and learning vocabulary.

Research Questions and Hypotheses

In order to meet the outlined objectives, the present research aims at answering the following questions:

Q1: To what extent is brain-based vocabulary instruction reflected in the Algerian fourth grade EFL textbook?

Q2: How often do Algerian fourth grade EFL teachers integrate brain-based learning principles in their vocabulary instruction?

Q3: How compatible are the fourth grade EFL textbook and teachers' practices with the Brain-Based Learning approach?

The following hypotheses have been suggested to answer the aforementioned questions:

H1: The vocabulary components in the fourth grade EFL textbook are organized in ways that support brain-based learning to some extent, such as contextualization and the use of visuals.

H2: The EFL Teachers adopt vocabulary-related classroom practices that in part reflect brain-based learning, including the use of body language and peer interaction.

H3: The textbook and teachers' vocabulary teaching practices are likely to reflect convergence, complementarity, and gaps in relation to Brain-Based Learning.

Research Techniques and Methodology

To conduct this research, a qualitative research method has been employed. The study is carried out in six selected primary schools located in Tizi Ouzou. For the data collection, two main instruments have been employed. First, all units from the fourth-grade EFL textbook have been analyzed, with particular focus on the integration of vocabulary instruction. Second, an interview is conducted to explore the strategies teachers implement to reinforce vocabulary learning in the classroom. The data collected are used to examine the techniques adopted for vocabulary learning in light of brain-based learning, and both sources have been using qualitative content analysis.

The Brain-Based Learning (BBL) framework (1991; 2009) lays the foundation for this study. It contends that effective teaching and learning occur when educators are aware of how the brain works optimally. In this context, Caine and Caine, in 1991, developed twelve principles on the brain's structure and function that support three interactive elements that serve as guiding conditions for a meaningful learning environment, namely relaxed alertness, orchestrated immersion, and active processing. It is important to mention that the twelve principles were later categorized under these three elements by Caine, Caine, Klimek, and McClintic (2009), which will be adopted as a model for the present research. This framework suits the current study well, as it offers a scientific basis for determining the extent to which instructional techniques align with the brain's functional mechanisms.

The Structure of the Dissertation

The current study follows the simple traditional model, consisting of a general introduction, four chapters, and a general conclusion. The general introduction begins by providing background information to contextualize the research. It then presents the problem, states the aim and the significance, outlines the research questions and hypotheses, introduces the methodology, and outlines the dissertation. The first chapter is entitled Review of the Literature. It reviews key theoretical concepts and existing studies relevant to the study with further explanation on the theoretical framework. The second chapter is entitled 'Methodology.' It presents the practical aspect of the research, describing the procedures followed for data collection and analysis. The third chapter is Presentation of the Findings. It reveals the results obtained from the data collected in an objective manner. The fourth chapter, "Discussion of the Findings," sets the stage for the analysis and interpretation of the results and objectively answers the research questions. Lastly, the general conclusion consolidates the key elements of the research, highlights both its contributions and limitations, and also outlines gaps for future research.

Review of the Literature

Introduction

This chapter reviews the core elements that underpin the present research and is organized into four major sections. The first defines neuroscience and explores its role in education, with particular attention to its relevance for language learning in early education. The second examines lexical development in young EFL learners, including their developmental characteristics, the concept of vocabulary instruction, and related pedagogical practices. The third outlines the link between neuroscience and lexical development. Lastly, it provides an in-depth look at the Brain-Based Learning framework (Caine et al., 2009).

1.1 Educational Neuroscience

1.1.1 Definition and Overview of Neuroscience

Recent years have witnessed growing attention to neuroscience; it is currently regarded as "one of the most rapidly growing areas of science" (Squire et al., 2012, p. 03). It can be defined as a scientific study of the nervous system, which consists of the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS includes the brain and spinal cord, which process and transmit information, while the PNS comprises the network of nerves that connect the CNS to the rest of the body.

The earliest written evidence related to neuroscience can be found in Ancient Egypt, where brain injuries were documented in the *Edwin Smith Surgical Papyrus* (Finger, 2001, p. 6). However, the conceptual foundation for understanding the brain's role in human thought, cognition, and the nature of emotions was disputed by pre-Socratic philosophers and physicians since the beginning of Greek civilization (Crivellato & Ribatti, 2007). Among them, Alcmaeon of Croton (sixth-fifth century B.C.) identified the brain as the seat of human senses, memory, knowledge, perception, and comprehension (Celesia, 2012).

"The word neuroscience did not gain use until the Neuroscience program was formed by Francis Schmitt in the 1960s and did not gain currency until the Society of Neuroscience

was formed in 1971." (*Shepherd*, 2010, p. 4). It is, thus, a recent area of science (Brown, 2019). In further detail, it is a multidisciplinary field that became formally recognized in the second half of the twentieth century (Shepherd, 2010). According to Gage (2015, p. 5), the modern era of this field began and continues to develop through the evolution of tools, techniques, and methods that allow us to study the brain and nervous system in greater detail and complexity.

At the core of this field lies the study of the brain (shepherd,2010), an intricate human organ, as stated by Sultana, Bandaru, Islam and Reddy (2024). Significantly, Gong (2014) explains that what makes it unique among all organs of our body is its role in controlling our mind and emotions, which define our identity and sense of self. Consistent with this, it is stated that

> Everything we do, every thought we've ever had, is produced by the human brain. But exactly how it operates remains one of the biggest unsolved mysteries, and it seems the more we probe its secrets, the more surprises we find (Tyson, as cited in Sánchez Nadal, 2021, p. 4).

Structurally, the brain consists of two hemispheres, the left and the right. They are connected via nerve fibers that allow communication and coordination between them. An important point to mention is that each hemisphere controls the opposite side of the body, meaning that the left hemisphere governs movements of the right-hand side and vice versa.

Additionally, every hemisphere specializes in different functions (Muñoz et al., 2012, as cited in Velez Tuarez et al., 2019, p. 29). According to them, the left hemisphere is associated with speech and language production, logical reasoning, analytical skills, and numerical calculations, while the right hemisphere is responsible for non-verbal functions, such as the ability to recognize faces, understand the arrangement of visuals, process emotions, and use intuition.

Indeed, neuroscience has contributed to broadening our understanding of the brain and how it works, which, in turn, informs various fields, leading to remarkable advancements. This can be seen in different studies demonstrating its significance. In the context of mental health

care, De Raedt (2020) reports that it enhances the clinical practice of Cognitive Behavioral Therapy (CBT) by guiding treatment approaches, such as the appropriate selection and application of CBT, and tailoring it to patients' neurocognitive characteristics, among others. As another contribution, neuroscience has played a fundamental role in advancing artificial intelligence (AI), which is known as a revolutionary technology. Hassabis, Kumaran, Summerfield, and Botvinick (2017) argue that the origins of AI methods are deeply rooted in neuroscience. For them, by understanding the brain's algorithms, architectures, functions, and representations, AI development is significantly inspired. Last but not least, it is undeniable that scrutinizing the human brain also plays a vital role in education. As indicated by Bowers (2016, p. 3), "it is widely claimed that the future is bright for forging links between neuroscience and education, and indeed, this collaborative approach is often described as a new discipline and given the name 'Educational Neuroscience.'"

1.1.2 The Function of Neuroscience in Education

Neuroscience is improving teaching practices and curriculum design as it is increasingly recognized that the more we learn about the brain, the better equipped we are to enhance the educational field. To illustrate, neuroscience laboratories are making substantial progress in understanding the neurocognitive development that underpins the acquisition of essential skills imparted by educators, as noted by Gkintoni, Dimakos, Halkiopoulos, and Antonopoulou (2023, p. 147). Indeed, rapid advancements in brain research are generating insights that can deepen our understanding of teaching and learning from new perspectives (Royal Science, 2011). This reflects a growing synergy between the two fields. To further elucidate, Royal Science's report states that

> Education is about enhancing learning, and neuroscience is about understanding the mental processes involved in learning. This common ground suggests a future in which educational practice can be transformed by science, just as medical practice was transformed by science about a century ago (Royal Science, 2011, p. v).

That is to say, education aims to optimize the learning experience by fostering the acquisition of skills and knowledge. In parallel, neuroscience offers insights into how the brain functions during the learning process, informing educators about the appropriate teaching approaches and learning environment for learners. As a corollary, this collaboration may address the longstanding impediments of education.

In the same line of thought, the intersection of these two disciplines has given rise to what is known as educational neuroscience. Thomas, Ansari, and Knowland (2019) assert that it is an interdisciplinary field dedicated to translating research findings on the neural mechanisms of learning into educational practice and policy. Additionally, they explain that the relationship between education and neuroscience can operate directly, by considering the brain's biological needs for optimal learning, or indirectly, through neuroscience informing psychological theories, which then influence education. However, despite the fact that educational neuroscience draws upon a wealth of learning methodologies, its direct contribution to teacher training and classroom practice remains minimal (Gkintoni et al., 2023, p. 153). Hence, according to their findings, neurotraining for educators is essential to effectively integrate neuroscience insights into their practice, which in turn supports the development of students' abilities by fostering both cognitive and social dimensions.

Moreover, it is important to mention that the application of neuroscience within educational contexts has faced criticism (e.g., Bowers, 2016; Goswami, 2016), questioning its practical applicability and theoretical foundations. Nevertheless, it is argued (Thomas et al., 2019) that the potential connections between the two fields are being actively explored worldwide.

1.1.3 The Role of Neuroscience in Language Education

The incorporation of neuroscience in education has yielded significant benefits. Indeed, "the advancement of progress in neuroscience encourages the drafting of efficient theories and

models of language education" (Sinani, 2013, p. 615). For example, Sinani explains that, according to findings in neurolinguistics, when learning a foreign language, the brain builds new systems within the neurofunctional schemes that are originally responsible for first language acquisition. These new systems, sub-neural systems, can only grow strong if the new language is learned and used meaningfully and in an emotionally engaging environment. This suggests that insights from brain research can inform and improve language teaching practices.

In a further critical aspect, Bagherkazemi and Shekarabi (2023) reveal that the Neurolinguistic Approach (NLA), a neuroscience-based method for foreign language teaching focused on memory, consciousness, and external/internal knowledge dichotomy, holds promise as an alternative to traditional grammar instruction by addressing its limitations. That is, it embeds both explicit (conscious, automatic knowledge) and implicit (unconscious, rule-based knowledge) grammar by moving beyond form-focused or solely explicit instruction through a sequence of oral, reading, and writing activities. This sequence aligns with how the brain processes language via the systems of declarative memory (conscious recall) and procedural memory (skills and actions), promoting meaningful language use.

To conclude, neuroscience findings, as noted by Goswami (2011, p. 55), go beyond scientific curiosity and offer an evidence base for education. Put differently, they provide a scientific understanding of how language is acquired by uncovering the brain mechanisms involved in learning.

1.1.4 Neural Pathways in Early Language Learning

Research has shown that learning a language other than one’s native tongue enhances communication and neurological abilities by strengthening brain connections. This is evident in a study demonstrating its role in developing two components of executive function, namely cognitive flexibility and working memory (Shoghi & Ghonsooly, 2018). This process of language learning is a driving force not only for linguistic skills but also for holistic

development, including personal, physical, mental, emotional, and social features of the person (Boukerkour, 2016). It further contributes to cultural awareness and tolerance (Muijs et al., 2005 p. 37, as cited in Cable et al., 2010, p. 44). Alongside these findings, it is concluded by Canto (2019) that introducing a foreign language before puberty is crucial for effective learning, as Phillips (1993, p. 5) believes, 'the younger the children are, the more holistic learners they will be."

In the same line of thought, Kennedy (2006) referred to a study conducted by Kim, Relkin, Lee, and Hirsh (1997), which revealed that the brain stores a second language in different zones depending on the age at which bilingualism begins. To better explain, when children learn a second language, Broca's area, responsible for speech production, is able to integrate both the native and second languages into one shared system or same neural area, which supports native-like pronunciation and fluency (see figure 1). In contrast, adult learners tend to store new languages in separate brain regions or neural locations, making fluency more difficult to achieve. Through this study, Kennedy (2006, p. 475) states that "this finding supports the argument that foreign language instruction should be included in elementary and middle school curriculum". Consequently, this has been recognized in the National Language Strategy in England (DFES, 2002 p. 15) by defining the primary entitlement as follows:

> Every child should have the opportunity throughout Key Stage 2 to study a foreign language and develop their interest in the culture of other nations. They should have access to high quality teaching and learning opportunities, making use of native speakers and e-learning.

This statement reflects a strong emphasis on both cognitive and affective dimensions of learning. Such a dual focus resonates with constructivist and social cognitive perspectives, both of which recognize that effective learning requires not only cognitive but also emotional and motivational engagement (McLeod, 2025; Bijandi, 2012). In this sense, these theories converge with the assumptions of BBL, which likewise underscore the interdependence of thinking and feeling in the learning process.

At Key Stage Two (ages 7-11), which aligns with Piaget's *concrete operational stage* (Piaget, 2000), children begin to reason and think logically, marking a critical period of cognitive development. Myles (2017) notes that at this level, learning a foreign language not commonly used in the community is cognitively demanding task. This underscores the need for highly effective instruction.

The teaching is a multifaceted process, for it involves not only delivering the curriculum but also considering the instructional methods. In order to meet the needs of the classroom and gain the 21st-century skills, Dulay (2023, p. 112) claims that "effective teachers are no longer just expected to be subject matter experts, but also the ones who can adapt to changing learning environments, use technology to engage, motivate and promote meaningful experiences for students with various needs."

1.2 Lexical Development in Young EFL Learners

1.2.1 Characteristics of Young Learners

A paramount number of studies have emphasized the fact that a teacher of a foreign language is required to have a thorough understanding of young learners to condition the appropriate teaching approach for their learners (Aslamiah, 2022, p. 114; Almalti, 2018, p. 378). According to McKay (2006, p. 1), young learners are children of primary or elementary school. In this regard, some of their characteristics are presented. To begin with, Přibilová (2006, p. 11) has noted that children of age seven to eleven are imaginative thinkers, through which, according to Li (2022, p. 1), their mental development matures. They love when they are paid attention to and praised. They are also enthusiastic, lively, and active learners. This means, as Bidzakin (2023, p .37) explained, that they learn through acting, doing, and interacting; therefore, pedagogy that encourages children active involvement should be utilized to enhance their learning.

In addition, Scott and Ytreberg (1990) highlighted significant points regarding the nature of children and their way of learning. According to them, children learn by engaging their senses, allowing them to explore their environment and interact with others, so they stated that "most activities for the learners should include movement and involve the senses." Indeed, words are not enough, and this is in line with Manja, Masnan, Mustafa, and Abdullah (2022, p. 10) who report that creating a multisensory environment through activities that stimulate visual, auditory, olfactory, tactile, and kinesthetic senses is essential because, according to Patch (2020, as cited in Syazwani et al., 2022), such stimulation positively impacts their language and speech development, as well as memory.

Furthermore, children understand and develop their language through concrete things. According to Roldao (1992, p. 13-14), this is due to their mental processes, which primarily rely on practical and observable facts. Over time, their cognitive abilities develop from '*experience-based perceptions'* to '*the abstractions of concepts.'* In light of this, early educational activities based on direct observation and concrete experiences are recommended as effective ways to align with this progression.

It is important to mention that children are easily distracted; hence, Scott and Ytreberg (1990, p. 5) suggest that "since concentration and attention spans are short, variety is a must" in terms of activities, pace, and organization.

To conclude, breaking down the umbrella term 'young learners', as indicated by Pinter (2012, p. 106), paves the way for accommodating the teaching techniques and materials that meet the needs and motivations of learners, which can be particularly significant for foreign language young learners.

1.2.2 EFL Vocabulary Instruction

Broadly defined, vocabulary is the understanding of words and their meanings. However, Ur (2006, p. 60) explains that it includes not only single words but also multi-word

expressions, such as 'post office' or 'mother-in-law,' which convey a single idea. Accordingly, to cover all such forms, the vocabulary 'items' is used rather than just 'words.'

With regard to vocabulary teaching, authors like Schmitt (2008) often use the terms 'lexical instruction' and 'lexical tasks' in a related way as two sides of the same coin, since activities and tasks represent the tools through which instruction is enacted.

In EFL contexts, vocabulary is considered "one of the skeletons of the language that pupils are expected to learn at an early age" (Bedilu and Degefu, 2022, p. 153). Indeed, a sufficient lexical repertoire provides them with the necessary linguistic resources to decode meaning and construct sentences, and express ideas effectively in the target language. Thus, it is reasonable to say that vocabulary knowledge underpins key components of language acquisition, including speaking ability, writing skills, and listening comprehension. This aligns with Richards and Renandaya (2006, p. 255, as cited in Suardi & Sakti, 2019, p. 93) who affirm that vocabulary forms the foundation of overall language skills. For this reason, educators endeavor to employ pivotal paradigms to effectively build learners' lexical knowledge.

Indeed, teachers are responsible for updating their knowledge and methods by staying informed about educational theory and best practices (Clerkin, 2013, p. 78). This responsibility helps explain the rationale behind numerous studies examining how teachers teach EFL vocabulary to young people across contexts. To illustrate, a research work entitled *"Theorized Vocabulary Teaching: An Analysis of Teachers' Views and Practices in Primary Schools in Tizi Ouzou"* revealed that EFL teachers employ various vocabulary teaching techniques, including flashcards, drawings, realia, and games. It concluded that, although teachers may not be consciously aware, their practices are guided by established teaching theories rather than applied randomly (Djouaher, 2023, p. 47). Another key study by Bedilu and Degefu in 2023, examined teachers' perceptions and classroom practices in teaching vocabulary to young learners and found that although teachers recognize the importance of teaching vocabulary by

applying strategies like creating an anxiety-free environment, using senses, realia, flashcards, and translating only when necessary, their actual practices still centers on word definition and translation into the mother tongue.

Significantly, teaching English to young learners should involve age-appropriate, engaging materials, such as textbooks, storybooks, songs, games, and other resources that encourage a supportive atmosphere, and promote language development (Islahuddin, 2023, p. 510). This reflects the fact that the textbook remains one of the most widely used instructional materials. It is an instructional guide developed by experts for educational stakeholders, including teachers, learners, and even parents. As noted by Ayu and Indrawati (2018, p. 21), a textbook serves both as a guide and as a source of input through its explanations and tasks. However, despite its significance, Gak (2011, p. 77) states that "there is no ideal textbook, ideal for every teacher, ideal for every group of learners and ideal in every teaching situation." For this reason, various studies have examined how EFL textbooks for young learners present and teach vocabulary. One such study, by Nordlund and Norberg (2020) in Sweden, found that most vocabulary exercises focus on incidental learning, where learners are not guided to reflect on how words function in context. As a result, it recommends that teachers to go beyond the textbook to better support vocabulary development (p. 107). Additionally, Biseko (2025) examined Tanzanian EFL textbooks and found that their tasks require learners to replace bolded words with their opposites, alongside integrating meaning, spelling, pronunciation, reading, and sentence construction. They also use pictures, dictionary references, and contextual examples to support vocabulary use in both spoken and written language.

1.3 Lexical Development through Neuroscience

The integration of neuroscience, particularly in education, has elicited notable considerations of vocabulary instruction. In connection with this, Dansie (2016, p. 159) notes that most teachers have little understanding of how learning occurs. By referring to Sousa

(2011), who highlights that while there are many how-*to* books available, educators need to focus on the *why-because-how-to*, Dansie explains that learning the basics of educational neuroscience would be beneficial for both teachers and students, especially in vocabulary learning and retention, which remains one of the main challenges in foreign language learning.

Relatedly, in an experimental study aimed at improving vocabulary acquisition, the Brain-Based Approach (BBA), an educational framework grounded in neuroscience, is implemented with primary school pupils aged seven to nine through activities like magic eye, lip reading, and balloon word. The post-test results showed significant improvements in enhancing the focus, comprehension, and creation of a motivating environment that encouraged active learning without boredom. The study also found that teachers need to be equipped with training that provides effective exposure to neuroscience-informed methods, helping them better understand how memory and learning work (Mestari, 2023).

Furthermore, recent studies show that knowledge in the declarative (explicit) system can become procedural (implicit) through practice, while procedural knowledge can turn to declarative via reflection or instruction (Faruji, 2012, p. 37). Thus, understanding this interaction allows teachers to design vocabulary lessons that guide pupils from learning words through conscious recall to using them automatically through meaningful practice.

In essence, neuroscience reveals how the brain learns, stores, and retrieves vocabulary, explaining that learning a word involves forming meaningful neural connections rather than mere memorization. Echoing this, Kelly (2017) states that “neuroscience takes us inside and, in addition to unraveling these mysteries, provides insights into many more aspects: attention, motivation, engagement, developmental change, logical processing, emotion, sensory input, character formation, learning disorders, and more,” (p. 1) all of which contribute to lasting vocabulary retention.

1.4 Brain- Based Learning (Caine et. al., 2009): The Analytical Framework

Within the arena of vocabulary instruction, numerous models have been proposed to explore effective methods for enhancing learners' retention and comprehension. Among these, Brain-Based Learning (BBL) has garnered increasing attention as a promising approach to developing vocabulary skills (e.g., Salem, 2017; Anderson, 2016; Dansie, 2016, as cited in Aguilar et al., 2024). It can be viewed as a comprehensive approach that offers a biologically grounded foundation for designing instruction aligned with how the brain naturally learns.

Many educators and psychologists have been forerunners in the BBL movement (Connell 2009, p. 29). Among them are Caine and Caine, who, in their book *"Making Connections: Teaching and the Human Brain"* (1991), originally postulated twelve principles gleaned from research on the brain's optimal functional state, which, according to them, provide us with a framework that revolutionizes teaching methods and practices (p. 79). Emerging from these principles, three instructional elements, namely relaxed alertness, immersion in complex experiences, and active processing, have been introduced as guiding conditions to establish a productive learning environment.

Building on this foundation, the framework was developed by Caine, Caine, Klimek, and McClintic in 2009 in their book named "*12 Brain Based Learning in Action: Developing Executive Functions of the Human Brain."* Indeed, they have revised and consolidated the twelve principles into the three fundamental components to enhance clarity, structure, and applicability in the context of education to improve the way teaching is performed (Rodriguez, 2018, p. 163). As such, the present study adopts the sequencing model proposed by these authors.

Importantly, this model underpins the premise of the present study as it informs instructional practices by identifying didactical elements whose presence across educational practices fosters an enriched learning experience that is aligned with the brain's optimal learning

state. In this way, it supports the aim of this research by steering the process of investigating how the brain-based learning approach is employed in EFL vocabulary instruction for primary school learners.

1.4.1 Relaxed Alertness

This component refers to "the optimal state of mind for meaningful learning" (Caine et al., 2009, p. 21). According to them, this state is characterized by a balance where the learner feels both relaxed and emotionally engaged or excited. In this way, they are encouraged to take risks in thinking, asking questions, and experimenting, which fosters a feeling of competence, confidence, and a sense of meaning. The principles that aim to promote the inclusion of this element are as follows:

- Complex learning is enhanced by challenge and inhibited by threat associated with helplessness and fatigue.

When the brain feels threatened (stress and fear), it stops working at its best. Indeed, Jones (2013, p. 53) reports that a wide range of research in areas such as neuroscience, stress theory, creativity theory and perceptual psychology has demonstrated that fears associated with helplessness can undermine effective mental functioning, which in turn sabotages meaningful learning. In the context of English language teaching, Rodriguez (2018) advocates for planning activities in a gradually challenging manner because when children, for instance, succeed in acquiring and using new vocabulary, they experience a sense of progress, which encourages them to continue learning.

- The brain is social.

To support the notion that the brain is social, Caine, Caine, Klimek, and McClintic (2009, p. 14) introduced the concept of mirror neurons. They can be defined as a type of brain cell that responds both when a person carries out a specific movement and when they observe another individual performing the same or a similar action (Kilner & Lemon, 2013). This neural

mechanism illustrates the brain's capacity to form and reinforce connections through observation and social interaction. That is to say, the brain develops more effectively through interaction with others (Wilson & Spears, 2007, p. 3). This indicates that a social environment strengthens neural plasticity (connection) and improves learning. To uphold this principle, Rodriguez (2018) highlights the importance of structuring lessons around social interaction, where the learners are allowed to use, play, and discover features of the language with their peers.

- The search for meaning is innate.

The human brain is naturally curious and inclined to seek understanding, especially of things that capture our interest. Thus, the more our learning is connected to personal and meaningful experiences, the deeper and more lasting it becomes (Caine & Caine, 1994, p. 96, as cited in Ceylan & Saka, 2022, p. 418). As per this principle, learners, as highlighted by Rodriguez (2018), need to recognize the value of an activity by engaging in discovery and problem-solving so that their natural curiosity is activated, thereby strengthening memory.

- Emotions are critical to patterning.

According to this principle, emotions are critical to learning and cannot be separated from it. Indeed, neuroscientific findings highlight the integral role of emotions in guiding thoughts, decisions, and actions (e.g., Demasio, 1999; Pert 1997; Pessoa, 2008, as cited in Jones, 2013). In substance, educators who understand the connection between emotions and learning can foster Relaxed Alertness (Caine et al., 2016). By extension, Rodriguez (2018) explains that they are responsible for igniting emotions in students by designing tasks that reflect previously mentioned principles, such as interest, inclusion, relaxation, and curiosity, which will lower the brain's affective filters.

1.4.2 *Immersion in Complex Experiences*

According to Caine, Caine, Klimek, and McClintic (2009, p. 7), the human brain's first engagement with the world is sensory. Therefore, learning must engage the senses, including sight, hearing, smell, and movement, which are naturally stimulated through physical interaction with the environment. Additionally, learning occurs through connecting new experiences to prior knowledge, so instruction should prompt learners to associate new content with what they already understand. Another important fact is that because the brain thrives on experiential learning, learners are more likely to internalize new knowledge when they are given opportunities to use it in meaningful ways, such as solving problems, applying vocabulary in context, or responding to questions. Corroboratively, this element is underpinned by a set of principles, outlined below.

- The brain/mind processes parts and wholes simultaneously.

The brain's hemispheres have distinct functions but are designed to operate simultaneously (Ceylan & Saka, as cited in Korkmaz, p. 809). In this instance, making sense of experience requires both an overarching view and attention to individual parts and details (Caine et al., 2016, p. 50). Supporting this idea, Gestalt psychology clearly illustrates how the mind connects separate elements into unified wholes (Sternberg, 2008, as cited in Caine et al., 2016). For this reason, Caine and Caine (1991, p. 83) accentuate the importance of recognizing the fact that the brain tends to process information both by breaking it down and by perceiving it as a whole.

- All learning is physiological.

According to Caine, Caine, Klimek, and McClintic (2016), the brain, body, and mind work together as a unified system, and to support this, they referred to neuroscientist Antonio Damasio (2005), who shows that the brain and body form an inseparable unit, and their interaction with the environment occurs as a whole. To rephrase, they function in tandem to

produce a comprehensive response to external stimuli. Indeed, this implies that focusing solely on the intellect falls short of effective teaching, as highlighted by Sarita (2017, p. 684).

- The searching for meaning occurs through patterning.

Neurons in the brain communicate by forming connections known as synapses, which are essential for learning (Rodriguez, 2018). In further detail, Caine and Caine (1991, p. 81) report that the brain naturally seeks to organize information by detecting logical relationships, but it resists meaningless or irrelevant input. These connections link new content with prior knowledge, so learning is more effective when instruction builds on what students already understand (Rodriguez, 2018). In light of this, Caine, Caine, Klimek, and McClintic (2016) emphasize that education should aim to expand the range of meaningful associations learners can recognize, apply, and express.

- Learning is developmental.

Although humans share a predictable process of development, they rarely grow or learn at the same pace or in the same way (Caine et al., 2016). This shows that children may mature at different rates, making it inappropriate to expect equal achievement based solely on chronological age (Caine and Caine,1991). In this light, Jones (2013, p. 52) concludes that students can comprehend better when their differences in growth, prior learning, and development are acknowledged.

1.4.3 Active processing

The two previously mentioned elements are not sufficient on their own (Caine & Caine, 1991, p. 147; Caine et al., 2016). Indeed, even a well-designed and immersive lesson may fail to engage learners if it lacks guidance for processing and reflection. In this case, the onus is on the teacher to consistently prompt them to summarize, analyze, reflect on, demonstrate, and communicate what they are learning for feedback (Caine et al., 2016). In essence, this aspect,

'*active processing,'* is defined (Caine & Caine, 1991) as the route to comprehension, rather than mere memorization. Demonstrably, the principles that support this component are highlighted.

- There are at least two approaches to memory: archiving isolated facts and skills or making sense of experience.

Memory is often divided into declarative (knowing facts) and procedural (knowing how). However, a more relevant distinction for educators lies between rote memory and dynamic memory (Jones, 2013, pp. 51-52). The former focuses on storing isolated pieces of information, skills, and procedures, while the latter is used to make meaning of experiences and construct new knowledge that can be applied spontaneously in everyday contexts (Caine et al., 2016). Ultimately, learners can master the subject matter when various memory systems are activated simultaneously.

- Learning involves both focused attention and peripheral perception.

This principle is guided by four main factors: interest, novelty, emotion, and meaning (Caine et al., 2009, as cited in Rodriguez, 2018). In fact, humans are constantly surrounded by various stimuli but tend to focus only on what aligns with these factors. In this instance, teachers may capture learners' attention by introducing the lesson in an interesting, new, or unexpected way (Rodriguez, 2018). According to Jones (2013), they also unconsciously absorb background input, as demonstrated by research on implicit learning and mirror neurons, which explains how children internalize behaviors, beliefs, and preferences. Taken together, this suggests that language learning becomes more effective when learners are deeply engaged and supported by rich, meaningful context.

- Learning always involves conscious and unconscious processes.

Learning occurs at different levels. Some through conscious effort and some through unconscious processing, like when creative insights emerge after initial reflection. This

demonstrates that pupils learn more effectively when given time to reflect on what they have learned and manage their own learning (Jones, 2013, p. 51).

- Each brain is uniquely organized.

While all humans share the same set of systems such as the senses and core emotions, they are uniquely integrated within each individual brain (Caine & Caine, 1991, p. 87). To elucidate further, each brain is shaped by distinct personal experiences. Thus, this principle, according to Rodriguez (2018), underscores the importance of differentiated instruction as learners vary in language proficiency, prior knowledge, and learning skills.

As established earlier, the principles position the instructional elements as defining features of great teaching. These three components are not separated but interconnected (see figure 2); they must be understood by teachers and integrated by educators (Caine, et al., 2009, p. 6).

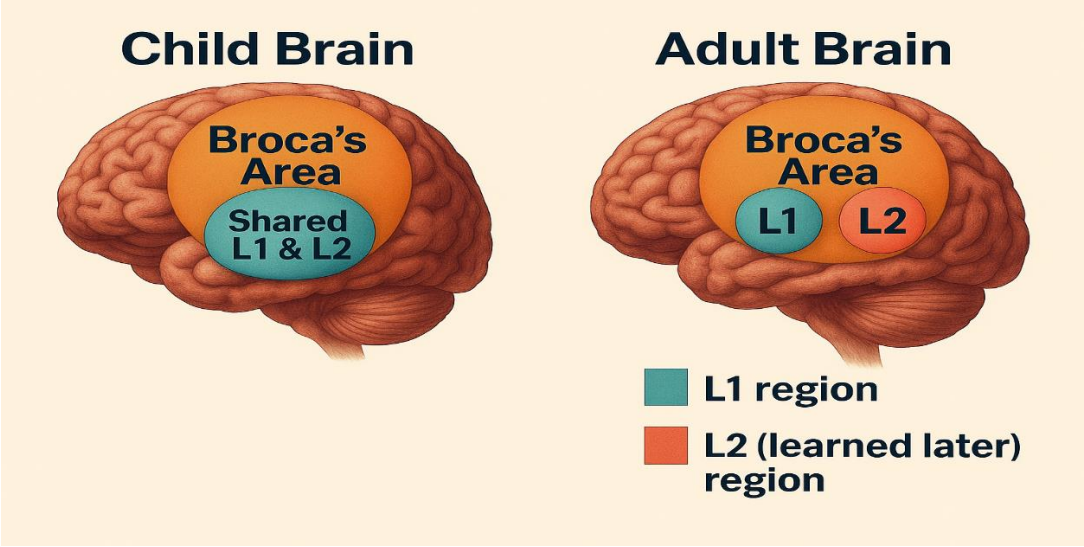

Figure1: Brain mechanisms in learning languages: Child vs. Adult.

Remark: This illustration is created by the author for this study

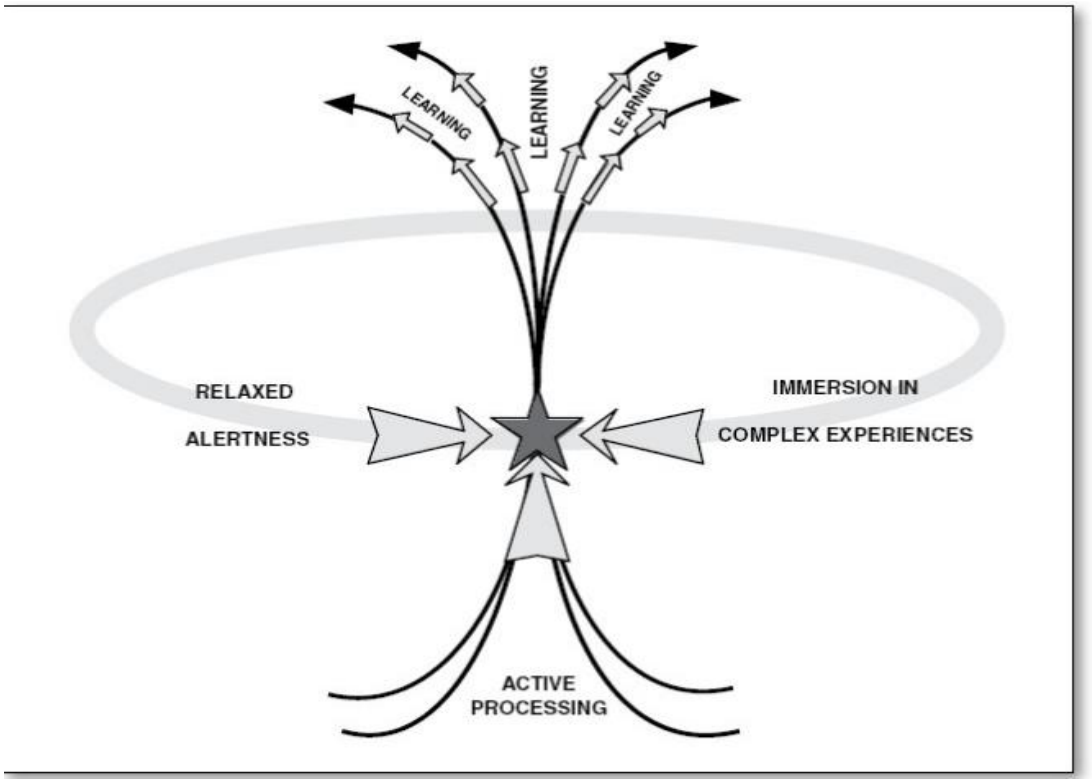

Figure2: The interplay of the three instructional elements

Remark: Diagram taken from Caine, Caine, Klimek and McClinton (2016).

Conclusion

This chapter has offered a comprehensive review of the literature related to the current study. As a starting point, it has defined neuroscience, examined its integration into the field of education, language learning, with particular attention to EFL young learners. It has then outlined their key traits, according to some experts in the field, and discussed vocabulary as a core language component, along with teaching practices and materials used across contexts. It has also established the connection between lexical development and neuroscience. Finally, the chapter has presented a thorough overview of the Brain-Based Learning framework (Caine et al., 2009), which underlies the analysis in this research.

Research Design and Methodology

Introduction

The current study seeks to investigate how the brain-based learning approach is reflected in vocabulary instruction, focusing on the techniques employed by teachers and those embedded within textbook content. Subsequently, it explores how compatible these two sources are with the brain-based learning approach. Thus, it becomes essential to dissect the methodological components upon which the present study is grounded to elucidate the research method, context, and sample selected, alongside the procedures and tools employed for data collection and analysis.

2.1. Research Method

This inquiry adopts a qualitative research methodology. As Malterud (2001, p. 483) explains, “Qualitative research methods involve the systematic collection, organization, and interpretation of textual material derived from talk or observation.” More expansively, qualitative research entails the meticulous analysis of non-numerical data, including texts, speech, and/or visuals, to explore experiences, opinions, or concepts (Bhandari, 2025). Indeed, Cleland (2017) found that it plays an important role in educational research by addressing the 'how' and 'why' questions, yielding an in-depth understanding of context and phenomena.

The present study adopts an exploratory approach as it seeks to investigate the extent to which current vocabulary teaching techniques applied in Algerian primary schools align with Brain-Based Learning. To achieve this, it examines teachers’ instructional practices through interviews and analyzes the official fourth-grade textbook to identify how vocabulary is presented and taught.

2.2. Data Collection Procedures

In order to achieve the aim of investigating the integration of the brain-based learning approach in vocabulary instruction for Algerian primary school EFL learners, this section presents the methodological foundations that guided the data collection process.

2.2.1 Context and Sample

The present study is conducted during the 2024-2025 academic year across six primary schools where English is taught as a foreign language. With a focus on vocabulary instruction, it targets six fourth-grade EFL teachers from the aforementioned settings. It also analyzes the official English textbook approved for this level as a data source.

In fact, "the best research designs should clearly explain why the particular setting was chosen" (Knott, Rao, Summers & Teeger, 2022, p. 2). To that end, primary school is selected as the research context because it involves learners in the foundational stages of foreign language learning, where vocabulary assumes a pivotal role in shaping basic communicative and comprehension skills. The choice of fourth grade, in particular, is pedagogically motivated, as it is at this stage that vocabulary usage expands and is taught in conjunction with other language skills. This makes it ideal for investigating the implementation of brain-based learning in both the instructional practices of teachers and the textbook activities designed to support vocabulary development.

In this research, a non-probability sampling method has been adopted for the interview phase. Specifically, convenience sampling is used to select teacher participants based on their accessibility, willingness to contribute, and current assignment as fourth-grade EFL teachers. This aligns with the argument that "using convenience sampling is bound to the researchers' choice considering access to the research context, participants, and methodological framework." (Koerber & McMichael, 2008, as cited in Golzar, Noor, & Tajik, 2022, p. 74).

2.2.2 Data Collection Tools

2.2.2.1 Definition of the interview

An interview is a tool used to gather information from individuals involved in this study. Kvale and Brinkmann (2009, p. 3) define it as "a conversation that has a structure and purpose. It goes beyond a spontaneous exchange of views in everyday conversation, and becomes a

careful questioning and listening approach with the purpose of obtaining thoroughly tested knowledge." Patton (2002, p. 341) emphasizes that interviewing offers insight into participants' internal perspectives and thought processes, namely what is in and on their minds. Hence, it can be inferred that interviews, as a method in qualitative research, produce textual data that reflect respondents' experiences, opinions, behaviors, attitudes, or characteristics.

2.2.2.1.1 Description of the interview

The interview phase involves six EFL teachers of fourth grade in six different Algerian primary schools in Tizi-Ouzou. The participants included both male and female teachers, and for ethical considerations, pseudonyms (T1- T6) have been used throughout the study. In addition to this, their responses have been recorded and transcribed verbatim, with only the transcripts retained for analysis. Editorial brackets (e.g., [...] to indicate omissions, [sic] to preserve original wording, and [and] or [them] for clarifications) have been employed when necessary to ensure accuracy and clarity in presenting excerpts. Importantly, this can be found in appendix B.

The interview part aims to elicit the vocabulary teaching techniques employed by these teachers and the extent to which they demonstrate alignment with the principles of brain-based learning. It has been conducted in April 2025 at the respective schools where the participants teach, namely: Frères Belkacemi (Belkacemi Brothers), الإخوة مدني (The Madani Brothers), خوليل أعمر (Khoulil A3mer), تواح فاطمة (Touah Fatma), حي الاستقلال ١ (Independence Neighborhood 1), and بلعالم سعيد (Belalem Said). Based on the availability and engagement of the participants, each interview has lasted approximately between 30 and 90 minutes, with some teachers providing more detailed responses than others. Specifically, the interviews lasted around 90 minutes at "Frères Belkacemi" and "الإخوة مدني," 45 minutes at "حي الاستقلال ١," 50 minutes at "بلعالم سعيد," 35 minutes at "Touah Fatma," and 30 minutes at "خوليل أعمر".

This interview consists of eleven (11) open-ended questions, encouraging participants to express their approaches based on both academic and personal experiences. A semi-structured format is then used to ensure consistency in the questions posed while allowing flexibility in how participants' responses are probed, enabling them to express themselves more freely and yielding richer data than a structured format would provide. It is also worth noting that interviewing six teachers from the selected schools has provided a sufficient basis for the intended analysis to obtain a reasonable amount of information as their responses have revealed recurring themes.

With respect to its structural organization, the interview consists of three main parts: an introductory paragraph, a general opening and closing question, and three thematic sections. The introductory paragraph explains the interview's purpose, setting the context for the findings. This is followed by a general opening question aimed at exploring participants' views on how understanding brain functions can influence vocabulary teaching. The goal here is to uncover whether the techniques they describe are intentionally applied or emerge unconsciously. The three thematic sections then probe the techniques linked to the core elements of brain-based learning (BBL), each through a dedicated set of questions: relaxed alertness (three questions), orchestrated immersion (three questions), and active processing (three questions). Finally, a closing question regarding their instructional approach.

Question (01): how do you incorporate knowledge of the brain and its functioning into your vocabulary teaching methods?

Question (02): How do you encourage learners to put effort into vocabulary learning without inducing stress or fear?

Question (03): if you view peer collaboration as an important aspect of vocabulary learning, could you please share how you usually foster interaction among learners in your lessons?

Question (04): How do you take into account learners' emotions when designing the vocabulary lessons?

Question (05): Do you teach vocabulary as isolated words or in relation to others? If both, how do you integrate them?

Question (06): How do you incorporate multisensory activities into vocabulary instruction?

Question (07): How do you adapt your vocabulary teaching approach to accommodate the varying abilities and proficiency levels of learners?

Question (08): When it comes to connecting newly introduced vocabulary with previously learned items, in what ways do you support your learners to form meaningful associations?

Question (09): If you go beyond rote memorization, what are the methods that you use to ensure that learners internalize vocabulary meaningfully and personally?

Question (10): If you recognize the importance of reflection in vocabulary teaching and learning, how do you guide your pupils in consolidating what they have learned before or after instruction?

Question (11): To end, would you mostly rely on the textbook, or do you incorporate your own techniques?

2.2.2.2 Definition of the Textbook Analysis

Textbooks are commonly used as the main material for teaching a particular subject; therefore, considering the quality and usefulness of their content is essential (Khine, 2013, p. 303). According to O'keeffe (2013, p. 1), they include various pedagogical and structural features that may impact learning either positively or negatively. Textbook analysis is then "a means by which these features can be identified and hence the effectiveness of textbooks be established".

Along similar lines, textbook analysis can be defined as a systematic examination of textbook content, structure, and elements to collect relevant data for research purposes, as

highlighted by O'Keeffe (2013, p.1). Significantly, Fan (2013, p. 771, as cited in Bittar, 2022, p.310) states that "the interest in analysing textbooks does not lie in inventorying what books bring: it is important to know 'how they are affected by other factors (independent variables) and how they affect other factors (dependent variables)'". That is to say, it goes beyond the description of content; it also considers the influences that shape textbooks and the effects they, in turn, have on teaching and learning.

In this regard, textbook analysis offers valuable insights and helps uncover the teaching techniques embedded within, making it an appropriate tool for exploring the reflection of brain-based learning principles in vocabulary-related content.

2.2.2.2.1 Description of the Textbook Analysis

The textbook analysis is used in this study to gather data from the fourth-grade EFL textbook used in Algerian primary schools for the purpose of providing a comprehensive account of how lexical instruction aligns with the principles of Brain-Based Learning. Accordingly, concrete examples have been identified and organized according to predetermined themes derived from the present study's framework.

To facilitate the analysis, a checklist has been designed, also colors are used to indicate the reflection of each dimension, with the aim of improving clarity and readability.

- In the section on Relaxed Alertness:

The corresponding colors	The dimensions
.	Emotional engagement
.	Challenge- Support balance
.	Interactive engagement

- In the section on 'Immersion in Complex Experiences'

The Corresponding Colors	The Dimensions
.	Contextual Learning
.	Connection to Prior Knowledge
.	Multisensory engagement
.	High-Complexity
.	Moderate-Complexity
No Color	Lower-Complexity

- In the Section on Active Processing

The corresponding colors	The Dimensions
.	Meaning-Making
.	Reflective Pause before New Input
.	Flexible Input for Personal Processing

The textbook analyzed in this study is called '*My Book of English'* (fourth year). It was designed for upper primary school learners by Hamina EL-Houcine (حمينة الحسين), officially introduced by the Algerian Ministry of Education, and published in 2023. This material consists of eight sequences, all of which have been examined as a collective unit of analysis.

2.3 Data Analysis Procedure

In light of the data collection procedure, it is worth noting that the data obtained from both teachers' interviews and textbook analysis are qualitative in nature. This informs the choice of analysis method to be adopted. Consequently, the data collected from these sources are interpreted using qualitative content analysis.

2.3.1 Qualitative Content Analysis

Qualitative content analysis can be seen as a method for organizing and making sense of data derived from interviews, documents, articles, or observations. To better explain, "it involves a process designed to condense raw data into categories or themes based on valid inference and interpretation" (Zhang & Wildemuth, 2009, p. 319). According to them, "the goal is to identify important themes or categories within a body of content" (p. 328).

As a key point, content analysis can be conducted inductively or deductively, depending on the purpose of the study (Elo & Kyngäs, 2008, p. 109). The former is a process that begins with no fixed assumptions, allowing patterns or themes to naturally emerge from repeated ideas in the data through careful examination, while the latter involves using thematic codes that are already set, based on an existing theory, to guide the interpretation of data.

In this research, the focus is to examine the compatibility between vocabulary-related textbook content and teachers' instructional practices in relation to Brain-Based Learning (BBL) approach. Accordingly, a deductive approach is adopted. In particular, the analysis of the textbook is guided by predetermined categories drawn from the present study's pedagogical framework, which also informs the design of the interview questions used with teachers.

Conclusion

The three sections presented in this chapter have provided an overview of the research design and methodology adopted in this study. At the outset, the qualitative research approach that guides the investigation is described. This is followed by the presentation of data collection

procedure, research context, and sample, along with the tools used, namely, teacher interviews and textbook analysis of the fourth-grade material. Finally, the chapter has explained the process used for analyzing the collected data.

Presentation of the Findings

Introduction

This chapter presents the findings of the current study, which investigates the techniques used to teach vocabulary to fourth-grade EFL learners in primary school, with the aim of examining the compatibility of both textbook content and teachers' practices with brain-based learning principles. It is divided into two main sections: the first outlines the findings of the textbook analysis, which was carried out on all the units, and the second outlines reports the results of the interviews conducted with six (06) teachers the findings of the textbook analysis, which was carried out on all the units.

3.1 Results of Textbook Analysis

The data obtained from the English textbook designed for EFL learners, specifically, the vocabulary teaching components and tasks have been organized, categorized, and analyzed according to the three instructional elements of Brain-Based Learning and their associated principles, as outlined by Caine, Caine, Klimek and McClintic (2009). The aim is to indicate the extent to which BBL approach appears by observing patterns of alignment, with color coding applied to enhance visual clarity. Accordingly, each of the three instructional elements is presented in a separate table, as shown below.

Remarks:

- the letter 'U' stands for 'unit
- the words (clear and partial) point to their corresponding dimension by being highlighted in the same color. If none of them is indicated, it means that the dimension is not reflected in the task.

➢ Relaxed Alertness

The dimensions	Task Evidence	The extent of presence
Emotional engagement	Structured dialogues at the end of each sequence: *p.47; p.62; p.85* ..	Clear - Clear – partial
Challenge- Support balance	Word search task/ pictures: school subjects /objects. *U3, p.45*	Clear partial
Interactive engagement	Fill-in-blank: visual support/ word choices. *U4, p.52*	Clear
	Word search: images indicating pain areas. *U4, p52*	Clear partial
	Select correct word for each image (games/celebrations) *(U7, p.75)*	Clear partial
	Match animals to their babies. Use of pictures and an example. *U8, p.82.*	Clear partial
	Discover, color, and name animal species (cat, sheep…) from illustrations. *U8, p.83*	Clear Clear

Table 01: Techniques reflecting Relaxed Alertness.

The results presented above highlight features of *relaxed alertness* in the fourth-grade EFL textbook lexical instruction. Across the tasks, visual cues and structured guidance are consistently provided, helping to sustain a balance between challenge and support during the input phase ***(e.g., match animals to their babies. Use of pictures and an example. U8, p.82.).*** Emotional engagement is evident, particularly in tasks involving word search tasks, visual matching, and coloring, while opportunities for interaction are periodically integrated at the end of each unit through structured dialogues, signaling a limited degree of social engagement.

➢ Immersion in Complex Experiences

The dimensions	Task Evidence	The extent of presence
Contextual learning	Read the conversation and match: characters /nationality. *U1, p.18*	Clear Clear
Connection to prior knowledge	Listen and fill in blanks with word *options (e.g., "This is my uncle. He is a ___"): carpenter, saw etc. U2, p.29.*	Clear- Clear Clear– Clear
Multisensory engagement	Use words from text and options to complete sentences .*U2, p.32.*	Clear- Clear
High- Complexity	Listen and match furniture to locations *U2, p.42*	Clear- Clear Clear
Moderate- complexity	Listen to a conversation and tick symptoms: fever, cough, etc.*U4, p.50.*	Clear- Clear Clear
Lower-Complexity (no color)	Listen and complete food baskets: visuals and word cues. (U5, p.57)	Clear- Clear Clear
	Read and link food items to the health problems they may cause (U5, p.60)	Clear– Clear Clear
	Extract job/sport vocabulary from text (U6, p.68)	Clear– Clear Clear

Table 02: Activities Demonstrating Immersion in Complex Learning.

This table presents the techniques used in the fourth-grade EFL textbook to reflect the instructional element of *Immersion in Complex Experiences*, particularly in vocabulary tasks. To begin with, vocabulary is regularly embedded within thematic units through texts or conversations, prompting learners to engage with meaning-focused tasks. Additionally, vocabulary input is presented in multisensory formats, mainly through incorporating visual, auditory and fine motor (kinesthetic) modes. For example, ***learners listen and match each celebration day to the corresponding image; U7, p.72***. Most tasks involve a moderate level complexity ***(extract job/sport vocabulary from text; U6, p.68)*** with few instances of basic tasks

(listen and match furniture to locations; U2, p.42). Furthermore, connections to previously learned vocabulary is only sparsely integrated.

➢ Active Processing

The Dimensions	Textbook Evidence	The Extent of Presence
Meaning making	Design a personal family tree and name each relative *U1, p.12*.	Clear Present
Reflective Pause before New Input	design a school map using target vocabulary *U3, p.38.*	Clear
Flexible input for personal Processing	Expand a list of school subjects and objects using prior knowledge. U3, p.45.	Clear Clear
	Classify food into 'healthy' and 'unhealthy' baskets. U5, p.58	Clear
	Classify words as 'fish' or 'cheese' using image clues. U5, p.60	Clear
	Cross out the odd animal in each group. *U8, p.92.*	Clear

Table 03: Tasks Exemplifying Active Processing

The findings presented above highlight the vocabulary teaching techniques used in the fourth-grade EFL textbook and demonstrate their connection to the brain-based learning element of active processing. The textbook moves beyond rote memorization by encouraging learners to expand, categorize or analyze ***(e.g., Learners cross out the odd animal in each group; U8, p.92.*** However, the open-ended tasks that promote personal engagement with content are rarely integrated, and opportunities for learners to pause, reflect, and process before encountering new input went unnoticed.

3.2 Results of Teachers' Interview

This section is dedicated to presenting the findings obtained from interviews conducted with six (06) fourth-grade EFL teachers from different primary schools in Tizi Ouzou. The participants were selected based on their assignment, willingness, and availability to describe the techniques and practices they use in teaching vocabulary. It is important to note that the results are organized according to the instructional elements of the brain-based learning approach.

Question (01): how do you incorporate knowledge of the brain and its functioning into your vocabulary teaching methods?

This opening question aims to determine whether participants' teaching techniques reflect brain-based learning principles intentionally through conscious understanding of brain functioning, or unintentionally through instinctive classroom practices.

All respondents acknowledged the importance of understanding how the brain functions and its readiness to learn when teaching vocabulary. Nevertheless, none actively pursued in-depth study of brain processes. Four respondents noted that, while they recognized its value, they rely mainly on direct observation of learners' needs, reactions and reflections to guide their teaching. Similarly, two others noted that they adapt their instruction based on individual differences.

Question (02): How do you encourage learners to put effort into vocabulary learning without inducing stress or fear?

For this question, the majority of respondents have indicated that they organize group work as a way of promoting effort in vocabulary learning without causing stress or fear, by assembling slow, shy, and advanced learners for mutual support. Two participants have highlighted the use of puzzles for group competition, with winners receiving gifts, so that everyone will strive for their best. As complementary strategies, two informants have stated

that they reassure learners that making mistakes is acceptable and that errors are a natural part of the learning process in order to speak, participate, and be active. One of them further noted that "I encourage them to participate even if it could be the wrong answer, not blame them, … I say you have the right to make mistakes, and I'm here to help you." Another said, "we praise, reward, and provide positive feedback to make them feel they are progressing." Two others have explained that they ask pupils to conduct research as part of their homework assignments to extend their vocabulary learning outside the classroom.

Question (03): if you view peer collaboration as an important aspect of vocabulary learning, could you please share how you usually foster interaction among learners in your lessons?

All participants have mentioned using group work and/or pair work to enhance interaction and collaboration among learners. Three respondents highlighted incorporating competitive games through group division. Regarding pair work, one participant has explained that they use worksheet-based tasks such as word searches, in which learners collaborate to identify letters that form words. Two others have indicated using the think-pair-share technique (TPS), whereby pupils first think individually, then discuss in pairs or small groups, and finally share their collective ideas to locate the target vocabulary. These two informants have further noted that the choice of collaborative methods depends on the task's difficulty.

Question (04): How do you take into account learners' emotions when designing the vocabulary lessons?

In response to this question, most participants have focused on selecting techniques and materials tailored to diverse learning preferences. In particular, they have reported using colorful flashcards for visual learners, incorporating songs for auditory learners, designing games, tactile activities such as realia, and gesture-based tasks like acting out words for kinesthetic learners. The respondents, two teachers have also referred to Bloom's Taxonomy, which helps them structure lessons from simple to more complex vocabulary use. As for the

remaining informants, they have highlighted designing their lessons according to learners' minds, simplifying explanations and tasks for accessibility while introducing selective challenges to stimulate more advanced learners.

Question (05): Do you teach vocabulary as isolated words or in relation to others? If both, how do you integrate them?

Half of the respondents have expressed a clear preference for contextualized vocabulary instruction. One participant has described using texts that contain target words and guiding learners to extract their meanings from the surrounding content, then added, "I display pictures to support the comprehension of vocabulary used in the text". Another one explained that, with experience, they moved away from isolated word instruction, realizing that "learners understand better when vocabulary is in the context". As a result, they now use dialogues containing the target words, which they consider the most effective method.

In contrast, others reported adopting a more blended method. Two teachers have succinctly stated that they begin with single words and then place them in sentences or texts, while another has explained that they start by presenting the vocabulary items in a list and teaching them through varied techniques "because some words need pictures, others gestures, or real objects... to transmit the meaning". As part of teaching standalone words, they also break the words into syllables "to help pupils understand how it is written and pronounced" before incorporating them into context through sentence-building and textbook-based tasks. Similarly, one participant addressed the question by indicating that they check learners' understanding of isolated words first and then help them grasp the meaning through simple, relatable sentences, as illustrated: "I ask them, 'What is daughter?' and then I try to help them by giving examples like, 'I am your mother, and you are my daughter".

Question (06): How do you incorporate multisensory activities into vocabulary instruction?

Even though the question is centered on how multisensory strategies are implemented, one respondent has addressed it by highlighting the rationale behind their use, aiming to accommodate the learning styles. Meanwhile, another has clearly elucidated, "I make my learners mime the vocabulary meaning through songs". Additionally, two teachers have indicated using Total Physical Response (TPR), saying that learners illustrate words physically through gestures, facial expressions, and activities like moving, running or/and acting. Four participants have also cited games as a common strategy, with two mentioning puzzles as a playful way of encouraging movement and critical thinking. Among them, two teachers have also described using role-play sessions, which they consider a form of action-based learning. Another teacher has reported that they mainly incorporate sensory elements like real objects to touch or food items to smell or taste, depending on the target vocabulary.

Question (07): How do you adapt your vocabulary teaching approach to accommodate the varying abilities and proficiency levels of learners?

Half of the participants (3 out of 6) have showed awareness of 'differentiation' in the classroom, explaining that they begin vocabulary lessons in their usual manner, then pay more attention to weaker or slower learners by simplifying content through gestures, contextual clues, and additional illustrations. One teacher has pointed out that "it is very difficult to manage these differences, but we try our best to simplify and …for learners with higher proficiency, we give them some challenging questions to figure out". Another explained that they assess all learners "to see their progress and weaknesses, so this way we will know whether to move on or use another way to clarify". Two respondents have highlighted repetition as a helpful strategy for supporting less proficient learners. More precisely, one referred to individual repetition "to, for example, focus on their pronunciation and explain what the word means if needed", while the other has remarked on their use of choral repetition, stating: "I am very familiar with my

learners, so I can focus on them while they blend in with the group, without drawing attention or making them feel embarrassed since some … are also shy". Additionally, some teachers noted that they either switch to the mother tongue or encourage learners to ask their peers for clarification.

Question (08): When it comes to connecting newly introduced vocabulary with previously learned items, in what ways do you support your learners to form meaningful associations?

When addressing this point, two participants provided unrelated answers. One of them merely reformulated the question without offering concrete strategies, while the other gave an unrelated example that did not address the idea of forming associations. In contrast, two participants have explained that they link vocabulary from different units. One illustrated, "*If I take the unit of **food** where learners already learned about chocolate and candies, and ... let's say... today's lesson is on **health problems**, I try to link them … for example, 'when you eat a lot of **chocolate** and **candies**, you get a **toothache** or a **stomachache***'". The remaining participants have described vocabulary extension as a form of association. As one explained, "we consider it as [consecutive lessons]; for instance, last year they learned the vocabulary for parts of the face, so this year we teach [the learners] other parts of the body by connecting it to what they already know".

Question (09): If you go beyond rote memorization, what are the methods that you use to ensure that learners internalize vocabulary meaningfully and personally?

Half of participants explained that they introduce the meaning of the word, and then move on to using it in context by forming simple sentences to make them familiar with the words' use, as one illustrated, "I ask them about things related to their own lives and preferences like What is your favorite hobby?" or "What is your father's job?", while another interviewee has described that they guide learners to infer meaning by using contextual clues rather than providing direct explanation or definition; for instance, asking, *"*When you are sick or have a

fever, you go to a...?" who? [to elicit] the word "doctor". Another respondent has mentioned using role plays, dialogue, and competition-based games like 'tic-tac-toe' (lexical practice) to check learners' understanding. One teacher has referred to the use of body language to help learners remember word meanings and noted that they encourage them to apply vocabulary in personal real-life situations, "for example, greeting their family members in English at home instead of their native language".

Question (10): If you recognize the importance of reflection in vocabulary teaching and learning, how do you guide your pupils in consolidating what they have learned before or after instruction?

All participants (6/6) view time for reflection as undeniably significant; for instance, one of them has explained that sometimes pupils respond in the moment, but what really matters is whether they remember the lesson later, which makes it possible for us to discover if they have actually learned it meaningfully or just forgot. However, the main obstacle that they shared is the only 45 minutes they have per session, as one stated: "our didactic guide advocates for asking learners what they have learned either by giving an activity or asking questions but I don't always apply this for the lack of time". Despite that, they have mentioned some methods if the time allows. One informant has explained, "I use brainstorming a lot, … [and] at the beginning of a session, I ask them to remind us of the last vocabulary lesson … if, at the end, there is a sufficient time, we try to summarize or use an activity in a sort of game". Two others have mentioned that they make learners use their slates to think about the question asked or task given. Additionally, a respondent stated that "the last 10/ 15 minutes is [sic] for recapitulation and assessment, we always have to finish the session with a task… In the next session, we start with a warm-up and sometimes, use a diagnostic test to see if they really remember the last vocabulary lesson before moving on".

Question (11): To end, would you mostly rely on the textbook, or do you incorporate your own techniques?

The majority of participants have reported that they do not rely only on the textbook for vocabulary instruction. As one said, “I definitely use other sources, especially to prepare some highly-challenging tasks to see the level of my learners.”, another one “I benefit from the textbook because of its exercises and examples”. While the textbook is seen as a general guide, most teachers indicated that it is not enough on its own to meet the diverse needs of their learners. For instance, in the words of one respondent, “I try to use tasks that are simpler than the ones of the textbook and sometimes more difficult to see how they can advance”. They use alternative resources, including online platforms, Facebook teaching channels, educational websites, and discussion with colleagues. These additional sources are used to access varied techniques, refine the level of difficulty, and design tasks to the specific objectives of each lesson. Teachers highlighted that they sometimes add simpler tasks to ensure clarity or more challenging ones to assess learners' progress.

Conclusion

This chapter has outlined the findings from the practical part of the study, based on textbook analysis and interviews with teachers. The results offer insights into the vocabulary teaching techniques employed in the fourth-grade EFL textbook as well as by teachers, presented through the lens of brain-based learning. They also set the stage for the discussion chapter, where their significance will be examined in relation to the analytical framework and the existing literature, in order to draw out their significance and implications for vocabulary teaching.

Discussion of the Findings

General Introduction

The present chapter addresses the research questions introduced in the General Introduction. It presents the findings obtained from the textbook analysis and teacher interviews. It discusses and interprets them in relation to the literature review and the analytical framework underpinning this study. Furthermore, it examines the validity of the hypothesis formulated at the outset of the research work. This chapter is structured around the three guiding research questions. First, it analyzes the way vocabulary components are presented in the textbook through the lens of Brain-Based Learning (BBL) principles. Second, it investigates how teachers approach vocabulary instruction in alignment with BBL principles. Third, it explores the extent to which the textbook and teachers' practices are compatible in terms of brain-based vocabulary instruction.

4.1 Answer to Research Question N#1: Reflection of Brain-Based Learning Approach in Fourth-Grade EFL Textbook.

This section addresses Research Question #1 by discussing the findings drawn from the analysis of the fourth-grade EFL textbook. It explores how vocabulary teaching techniques are implemented and sheds light on their objectives through the lens of brain-based learning.

4.1.1 Patterns of Vocabulary Instruction

The analysis of lexical instruction extracted from the EFL textbook has revealed a variety of instructional techniques designed to build a foundational linguistic profile for beginner-level learners. One teacher noted in response to question #11, "I benefit from the textbook because of its exercises." The evidence suggests that while the textbook offers guided input for learners, it also operates as a pedagogical framework for instructors. As Dhand (1990, n.p.) explains, a teaching technique, including the use of a textbook, is a practical tool for teachers to deliver a lesson. Hence, the textbook's vocabulary methods for fourth-grade EFL learners reflect three main patterns of practice.

Contextual learning is one of the clearly noticeable teaching features throughout the units of the EFL textbook. It is primarily promoted through multisensory engagement**,** reading comprehension tasks, and scripted dialogues for practice. This means that vocabulary is reinforced through meaningful use, which reflects an effort to make learners aware of how vocabulary functions within real communication.

Furthermore, the textbook regularly adopts a form-meaning association pattern. In relation to this, although task formats vary, the textbook maintains a consistent use of visual design to help learners connect words to their meanings. Tasks such as ***matching animals to their babies with picture support (U8, p. 82)*** or ***selecting the correct word for each image (U7, p. 75)*** demonstrate this tendency**.** These pictorial representations can provide the background knowledge to help learners recognize what is happening (Levin, 1981, as cited in Hibbing and Rankin-Erickson, 2003, p. 769). This implies that the Algerian primary school EFL textbook tends to embed meaning mainly through visual clues.

Another feature of the EFL textbook's overall design is semantic processing as a way of engaging learners with vocabulary by retrieving words from memory and applying them meaningfully. For example***, learners are asked to classify words as 'fish' or 'cheese' using image clues (U5, p. 60)***, which appears to aim at encouraging learners to consider word-category relationships.

These findings, as obtained from the textbook analysis, highlight the range of techniques used to teach vocabulary to EFL learners. They show that the material relies on visual input to support word-meaning relationships and integrates vocabulary within short texts and dialogues. In some cases, learners are also engaged in tasks that require semantic reasoning. In light of this, it can be concluded that the Algerian primary school EFL textbook presents vocabulary in a way that is visually accessible, functionally applicable, and occasionally encourages thoughtful retrieval beyond recognition.

These findings resonate with those of the empirical study carried out by Biseko (2025) in Tanzania (see Section 1.2.2, Chapter 1). In brief, both the present study and Biseko's analysis align in the inclusion of vocabulary instruction that addresses form, meaning, visual support, and contextualization.

Turning to another study, as discussed in the literature review, Nordlund and Norberg (2020) aimed to examine *"Vocabulary in EFL Teaching Materials for Young Learners"* in Sweden. Their analysis found that most exercises focus on incidental vocabulary learning, where pupils are not guided to reflect on how words function in context, contrary to the current analysis of the Algerian EFL textbook, where it is found to be more prominent. Taken together, these emphases in the findings may be linked to varying educational policies, curricular goals, and underlying assumptions about learners needs. As Richards and Rodgers (2014, p. 19) state, "according to Anthony's model, approach is the level at which assumptions and beliefs about language and language learning are specified."

4.1.2 Functions of Vocabulary Techniques Through a Brain-Based Learning Lens

The Brain-Based Learning approach (Caine et al., 2009) identifies three key instructional elements through which meaningful learning and long-term memory can be achieved: Relaxed Alertness, Immersion in Complex Experiences, and Active Processing. The results drawn from the textbook analysis attest to varying degrees of alignment with these elements, as discussed below.

4.1.2.1 Textbook's Resonance with a Relaxed Alert State

Preparing learners to be alert and relaxed means creating a mental and emotional state where they feel both focused and safe. These two conditions are known to function in balance to support meaningful learning. In other words, if the brain lacks focus or challenge, attention may wander, and when it is challenged without emotional engagement or safety, stress may

occur and hinder learning. Table 1 from the textbook analysis reveals how far a mentally safe and engaging atmosphere is reflected in the vocabulary teaching components.

Effectively, the findings suggest that the textbook offers tasks built around familiar topics such as animals, food, celebrations, and family, where learners are encouraged to engage in practice that requires some mental effort while also benefiting from guidance and visual support, which simultaneously acts to capture their attention. This can be noticed in the following instances:

- **Fill-in-the-blank with visual support/word choices**; *U4, p. 52*: This task invites learners to choose the appropriate word to complete a sentence, which offers enough challenge to be involved cognitively while guiding them through options and illustrations to prevent overload.
- **Discover, color, and name animal species**; *U8, p. 83*: Learners identify vocabulary using colors and illustrations in a way that connects with their interests.
- **Select the correct word for each image (games/celebrations)**; *U7, p. 75*: This activity aims to familiarize learners with vocabulary related to experiences drawn from their own lives.

The analysis shows that the textbook aims to reduce learner stress by providing consistent support through visuals, guided options, and vocabulary related to concepts already encountered in their lives. Specifically, the colorful illustrations are used to function both as scaffolding and as a means of capturing attention, for they enhance children's imagination and shape their motivation (Kasmaienezhadfard, Pourrajab, & Rabbani, 2015). This suggests that the textbook engages learners cognitively by prompting active mental roles in a supportive way and emotionally through visual elements and relatable vocabulary.

Within the same line of analysis, emotional engagement involves sparking learners' interest, curiosity, and sense of inclusion (Rodriguez, 2018). This indicates that the textbook,

however, appears not to go far enough in stimulating curiosity and exploration, which, as indicated by Jirout, Vitiello, and Zumbrunn (2018), encourage learners to explore, face challenges, and take risks in what they find worthwhile. This unveils the importance of provoking curiosity through tasks that incorporate mystery, questions, or moments of wonder that prompt learners to make predictions and search for meaning.

Further scrutiny of the data uncovers that, although the textbook includes structured dialogues, most tasks appear to be designed for individual work (see Table 1). This highlights a limited emphasis on peer interaction that promotes mutual support or shared understanding. According to Caine and Caine (1991, p. 82), mental and emotional states are important, but learning is also influenced by the inherent need for social interaction. Therefore, it would be advantageous for textbook designers to integrate more activities in pairs or groups that allow learners to discuss and compare answers. This is further supported by Wilson and Spears (2007, p. 3), who argue that the brain strengthens neural connections through observation and interaction (see Section 1.4.1, Chapter 1).

In light of these findings, we are led to the conclusion that the Algerian primary school EFL textbook integrates mental focus with consistent scaffolding, suggesting that the balance between challenge and support is notably present. However, emotional and social engagement are limited in scope, as the former relies mainly on visuals and overlooks the aspect of curiosity which is fundamental to eliciting emotional involvement, while the latter rests on structured dialogues as the primary form of interaction; thus, the instructional element of relaxed alertness is reflected in a way that suggests a limited but noticeable presence.

4.1.2.2 Textbook's Representation of an Immersive Learning Experience

Immersing learners in rich experiences means placing them in a learning journey that integrates multiple senses, brain systems, and different types or levels of intelligence. In relation

to this, the findings drawn from the textbook corpus, as shown in Table 2, reveal the extent to which learners are exposed to such experiences when learning EFL vocabulary.

Predominantly, the material constructs learners' vocabulary repertoire by presenting words in a contextual, meaningful way, notably through texts, dialogues, and multisensory input. The following examples demonstrate these key features:

- **Listen and fill in the blanks: an image and word options are presented (*e.g., "This is my uncle. He is a ___": carpenter, saw, etc.)* U2, p. 29.** This task encourages learners to listen carefully to spoken input while also using the visual clue and the options, which together establish the context for learners to complete the sentence meaningfully.
- ***Read and link food items to the health problems they may cause (U5, p. 60):*** Learners are expected to understand how vocabulary related to food and health symptoms is embedded in a text, guiding them to make meaningful connections based on content comprehension.
- ***Structured dialogues at the end of each sequence: (e.g., pp. 47, 62, 85 etc.):*** Learners engage in a communicative task that requires them to perform role-plays, using the target vocabulary meaningfully to simulate real-life situations.

The findings above indicate that the textbook immerses learners in vocabulary learning by engaging their senses, meaning, learners are exposed to input that activates different memory systems associated with each sense, as in this case, the visual and auditory ones, forming multiple neural pathways to remember and use vocabulary when needed. It also encourages comprehension of target words in texts and makes use of dialogues for communicative purposes. Adding to this, it is noteworthy that the kinesthetic mode is reflected in tasks involving writing, linking, and other similar fine motor activities that require hand–eye coordination and small muscle movement (Sadaruddin et al., 2022, p. 229).

Along the same lines, in response to Question 11 during the teachers' interviews, some participants have reported that they primarily use the textbook for its texts and related vocabulary activities, corresponding to Krashen's idea (1989, as cited in Mediha & Mede, 2014) that reading is the context needed to teach vocabulary. The textbook's use of this method reflects the belief that meaningful learning occurs when it mirrors the natural, authentic ways in which we acquire our mother tongue. This is reinforced by Montasser (2024, p. 5), who asserts that learners should be engaged in activities that simulate real-life situations they may encounter outside the classroom.

As we dive deeper into what the data show, it becomes evident that the type of contextual learning in which vocabulary is embedded (texts and related tasks) occasionally includes references to previously learned words. For instance, the task ***"read and link food items to the health problems they may cause; U5, p. 60"*** demonstrates how a text is structured around vocabulary related to '*food'* and '*symptoms'*. The former (food) is covered in Unit 5, while the latter (health problems) is already introduced in Unit 4. This suggests that the textbook supports learners in forming logical connections between concepts, rather than presenting them as isolated items simply because they belong to different semantic fields. However, although such opportunities exist, this does not appear as a consistent feature in the instructional design (see Table 2).

Furthermore, when asked, in Question N#11, whether they rely solely on the textbook or use other sources, one teacher clearly stated, "I definitely use other sources, especially to prepare some highly-challenging tasks to see the level of my learners." This reinforces the findings of this analysis, which show that the tasks generally range from low-level complexity, such as ***"Listen and match furniture to locations; U2, p. 42"***, to moderate complexity, such as ***"Listen and complete food baskets using visuals and word cues; U5, p. 57."*** In other words, the textbook does not appear to target the diverse cognitive abilities of learners, particularly

those at higher levels. As seen in the framework, brain-based learning holds that learners rarely develop or learn at the same pace or in the same way (Caine, 2016). This underscores the need to better accommodate this diversity by enriching the textbook with more demanding tasks that meet the needs of advanced learners.

In conclusion, although the Algerian primary school EFL textbook does not fully attend to aspects such as regular connection to what was already taught or varied task complexity, it does, indeed, immerse learners in a rich, contextual vocabulary input with multisensory engagement involving sight, hearing, and fine motor movements, reflecting a strong enactment of immersion in learning experiences that align with Brain-Based Learning.

4.1.2.3 Textbook's Embodiment of Active Processing

Learners' involvement in active processing refers to how their brain works with knowledge as a way of moving from input to meaningful application and use by making sense of it and relating it to personal experience and understanding. In this regard, Table 3 from the textbook analysis unveils whether learners engage in this process when learning vocabulary.

As a clear feature, the textbook tends to encourage learners to make sense of vocabulary through such techniques as classifying, designing, or expanding. This can be noticed in the following tasks:

- ***Design a school map using target vocabulary*** *(U3, p. 38):* The learner is asked to express the meaning of vocabulary related to school, such as *classroom*, *lavatory*, etc., through drawing.
- ***Classify food into 'healthy' and 'unhealthy' baskets*** *(U5, p. 58):* This task invites learners to make decisions by sorting each vocabulary item into its appropriate category.
- ***Expand a list of school subjects and objects using prior knowledge*** *(U3, p. 45):* In this activity, learners are expected to provide their own vocabulary items that take the same lexical set.

These tasks demonstrate how the textbook encourages learners to engage with vocabulary from multiple angles until it sticks in their brain as usable knowledge beyond rote repetition. This means that learners process the meaning of the word, understand its grammatical category, or even distinguish what makes it different from other lexical items. However, it is important to note that active processing is about the consolidation and internalization of information in a way that is both personally meaningful and logically structured (Caine and Caine, 1991, p. 147). Within this context, personalization in a way that fits learners' understanding plays an important role in vocabulary processing. By looking at the results, this aspect, while present in tasks such as "***Draw a personal family tree and name each relative" (U1, p. 12),*** receives little emphasis in the overall task design (see Table 3). In light of this, it can be inferred that making sense of vocabulary is clearly considered, but it is not consistently linked to learners' background knowledge or personal experience. This opens up the opportunity to enhance the textbook by including more prompts that allow learners to connect the vocabulary they are learning with their own lives, routines, and even feelings.

Moreover, learners, as described in the analytical framework, should be given time to reflect on what they learn (Jones, 2013, p. 51) to allow the learning to consolidate. A closer look at the findings reveals that new input is introduced before learners have the chance to consolidate or reflect on what they have dealt with. This points to the need to provide summary tasks or integrative practice that allow them to recall the lexical items acquired throughout a given sequence or semantic field before moving on in the process.

The analysis leads us to the conclusion that the textbook moves beyond rote memorization and enriches learners' vocabulary in ways that keep their brains active. However, relating newly learned knowledge to learners' backgrounds or personal experiences, as well as allocating time for reflection and recall, are limited aspects, showing a selective presence of active processing.

Put all together, the analysis makes it clear that the Algerian fourth-grade EFL textbook demonstrates a mixed degree of alignment with the instructional elements and principles of Brain-Based Learning. Indeed, while there is a limited representation of certain aspects such as emotional engagement, connection to prior knowledge, high-complexity tasks, personalization, and reflection, the findings highlight areas for enhancement, many of which are addressed through targeted suggestions. These findings echo those of Haghighi (2013)**,** whose study on *"The Effect of Brain-Based Learning on Iranian EFL Learners' Achievement and Retention"* has found that brain-based learning can guide educators, textbook developers, and course book designers in areas such as memory retrieval, attention, learning styles, and emotional engagement**.**

To sum up, although the aforementioned areas are not readily apparent, the textbook reflects relaxed alertness particularly through its use of visuals that make up part of learners' interests, and by maintaining a balance between challenge and support by involving cognitive operations along with scaffolding. It also demonstrates considerable opportunities for immersion in complex experiences, due to its consistent use of meaningful design and multisensory input, facilitating memory encoding. Another critical consideration is that the textbook teaches vocabulary with functional orientation, as words are introduced in relation to their communicative purposes rather than as isolated grammar points or word lists. This is thus seen as a manifestation of active processing. Hence, this section answers the first research question raised in the General Introduction: *"To what extent is the Brain-Based Learning approach reflected in the fourth-grade EFL textbook?"* Thus, the first hypothesis is confirmed.

4.2 Response to Research Question N#2: Fourth-Grade EFL Teachers' Integration of Brain-Based Learning in Vocabulary Instruction

This section addresses Research Question N#2 by discussing the results of the interviews, which aim to uncover how fourth-grade EFL teachers integrate the Brain-Based

Learning (BBL) approach into their vocabulary instruction. In order to do so, the study examines the techniques they employ, along with the objectives behind them, from a brain-based standpoint.

4.2.1 Teacher-Reported Vocabulary Techniques

The interview responses collected from six teachers across different primary schools of Tizi-Ouzou have revealed a range of techniques used to teach vocabulary. The most frequently mentioned ones included the use of flashcards, songs, games, physical activities, group work, and communication-based tasks.

In contrast to these findings, Alhatmi conducted an empirical study in 2022 aiming to investigate the vocabulary teaching practices used in Saudi Arabia. Based on questionnaire responses from 87 Saudi EFL teachers, including those at the primary level, the study found that they mainly rely on L1 Arabic translation, stimulus–response reinforcement patterns, etymology, board work (i.e., writing on the board), word mapping, and the use of non-textbook supplemental materials. Despite the fact that the two studies have employed different tools of data collection (interviews in the present research and questionnaires in Alhatmi's), the results highlight how this discrepancy in vocabulary teaching techniques is influenced by teachers' philosophies, experiences, beliefs, and cultural differences.

4.2.2 Vocabulary Teaching Practices in Light of Brain-Based Learning

The results drawn from the teachers' interviews attest to traces of Brain-Based learning elements, as elaborated in the subsequent discussion.

4.2.2.1 Teachers' Techniques for an Optimal Emotional State

As discussed below, Questions 2, 3, and 4 aim to uncover whether and how teachers promote an optimal emotional state, one that engages learners in a focused and motivating environment, in their vocabulary instruction.

To begin with, when asked how they encourage learners to work in a relaxing setting, though striking the right balance between low-threat environment and challenge is not always easy (Caine & Caine, 1991), most of them have referred to group work as a key strategy by bringing together the shy, the intermediate, and the advanced learners. According to them, it is an effective way to make them feel safe enough to accomplish a task, for they have each other. This reflects the claim that "group work can help improve the affective climate in the classroom, the intimacy of the small group setting often being especially valuable to shy or linguistically insecure students" (Long, 1990, p. 38). More to the point, this opens up a space for interaction and collaboration, as two teachers further highlight the use of the Think-Pair-Share (TPS) method, which allows learners to reflect individually, then discuss their answers together to locate the target vocabulary. Mundelsee and Jurkowski (2021) found that this technique increases participation after exchanging ideas with a partner. However, some teachers have noted that some learners are uncooperative, which, at times, leads to unproductive or negative social dynamics. This echoes Wilson, Romanaire, and Rethinasamy's (2023) findings, in which teachers similarly reported such challenges. Managing such situations hinges on the ability to maintain a supportive and structured classroom environment.

As far as motivation is concerned, the data further shows that learners are encouraged to participate by instilling in their minds that making mistakes is nothing to be feared and that help is always available when needed. As one puts it, "I encourage them to participate even if it could be the wrong answer, not blame them, … I say you have the right to make mistakes, and I'm here to help you". Another said, "we praise, reward, and provide positive feedback to make them feel they are progressing", contributing to positive self-efficacy (Caine et al., 2009, as cited in Johnson & Fitzgerald, 2013, p. 70). Indeed, children respond positively to attention and praise (Přibilová, 2006, p. 11), and this paves the way for learners to grow fond of the classroom atmosphere.

In light of these results, teachers do create a safe and active environment in which learners feel supported and involved. Indeed, they are encouraged to learn not only through their own experiences but also by observing their peers. This reflects key aspects of relaxed alertness in Brain-Based Learning, which calls for an optimal state of mind for meaningful learning (Caine et al., 2009).

When asked (question 4) about how they engage learners emotionally, most teachers have referred to accommodating learning preferences through colorful flashcards, songs, and games. These methods, in fact, align with learners' interests, as Scott and Ytreberg (1990) have noted, "since concentration and attention spans are short, variety is a must"; however, none of the teachers mentioned designing tasks that stimulate learners' intrinsic motivation, such as those driven by curiosity, exploration, or personal relevance. Piaget (as cited in Hohmann & Weikart, 1995, p. 23) states that "the role of the teacher [...] consists essentially in arousing the child's curiosity". This supports the fact that the human brain is naturally curious (Caine & Caine, 1994, p. 96, as cited in Ceylan et al., 2022, p. 418), so learners are often stimulated by novelty, mystery, or open-endedness, which can make them naturally inclined to respond to stimuli.

It can therefore be concluded that relaxed alertness is clearly reflected in most of the factors that promote it, such as a safe, interactive, supportive, and cognitively engaging environment. Yet, managing peer interaction and emotional engagement remain areas that warrant further development to foster a desire to learn, understand, and actively participate.

4.2.2.2 Teachers' Techniques for an Immersive Learning Experience

The interviews aim to explore whether and how their practices may echo the essence of the BBL instructional element, which surrounds learners in varied input to develop and deepen understanding.

Given the responses obtained from questions 5, 6, 7, and 8, it can be discerned that most teachers embrace this facet through a tendency toward contextual and experiential learning, along with lexical association and instructional flexibility.

When asked about their way of approaching the vocabulary meaning, half of them have reported introducing the target words directly within a context, either in texts or dialogues, for they believe that learners grasp its function more naturally. The remaining teachers have explained that they first introduce the word's form, as one of them stated, "to help pupils understand how it is written and pronounced." Then, they move to the meaning by asking guiding questions or using pictures, gestures, or realia, depending on how concrete or abstract the vocabulary is. After that, they take a step further by placing it into context through sentence-building or textbook-based tasks. The latter approach reflects the brain's ability to process information both by breaking it down and by perceiving it as a whole (Caine and Caine, 1991, p. 83). In other words, "the right brain has the tendency to see the wholes while the left perceives the parts of the learning process and the interaction between both hemispheres strengthens learning" (Wilson, Romanaire & Rethinasamy, 2023, n.p). These results indicate that, although the introduction of the word meaning varies, teachers ultimately contextualize it so that learners recognize its real function and understand its use.

Furthermore, the findings suggest that teachers enrich vocabulary input by engaging learners through the kinesthetic, visual, and auditory modalities. The participants have referred to Total Physical Response (TPR), games, songs with miming, or visual puzzles that involve movement and critical thinking. According to them, this playful strategy helps them get involved because it meets their energy, corresponding to Přibilová (2006, p. 11), who affirms that they are naturally enthusiastic, lively, and active learners. One informant mentioned engaging the tactile, olfactory, and even gustatory senses when needed, all of which, as Patch (2020, as cited in Manja et al., 2022) believes, positively impact memory. These findings

indicate that teachers not only contextualize vocabulary but also integrate multisensory learning, primarily through gross motor activities that combine large muscle movements with one or two sensory modalities. This is in line with Caine, Caine, Klimek, and McClintic (2016), who emphasize that learning involves the integrated functioning of the brain, body, and mind.

Beyond sensory engagement, immersive learning also requires a logical thread of connected ideas across vocabulary content. Question 8 reveals that the majority of informants attempt to create associations between newly and previously introduced vocabulary items. On the one hand, two participants have explained that they use familiar vocabulary from prior units to clarify the meaning of the new items by building relationships between them. One of the cited examples is linking the word "chocolate" *(food)* to "toothache" *(health problem)*. On the other hand, two teachers have noted that they extend vocabulary taught in a previous year; as one illustrated, "…last year they learned the vocabulary for parts of the face, so this year we teach [them] other parts of the body by connecting it to what they already know." Indeed, it appears that these teachers harness learners' preexisting knowledge in various ways, either by forming cause-effect relationships or by expanding lexical knowledge. Such forms of connection, in both cases, encourage learners to recognize, apply, and express (Caine et al., 2016).

Another key consideration in creating an immersive experience is the need to acknowledge individual differences (see Section 1.4.2, Chapter 1). A deeper layer of analysis reveals that, while teachers are aware of the need for differentiation and report making efforts to support each learner, they actually find it difficult to manage. As one put it, "It is very hard to manage these differences, but we try our best to simplify… ." As practical techniques, some participants have explained that after introducing the vocabulary lesson, they focus on the struggling learners. For instance, two teachers have highlighted individual or choral repetition as helpful strategies for addressing varied levels. The first is used to ensure each grasps the

correct pronunciation and meaning, while the second helps to observe who may need help as they practice together. Two others have referred to Bloom's taxonomy to sequence tasks cognitively. They have also explained that they prepare challenging questions or tasks for the advanced learners to figure out, while for the lower-level ones, if initial strategies prove ineffective, some resort to using the mother tongue translation or asking their classmates to clarify. These results imply that teachers try to cover all learners' needs through their own techniques, but it is still arduous for them to sustain this differentiation. A compelling takeaway may be drawn from the view of Ainscow and Messiou (2018) that it is imperative to engage with the voices of learners, especially those who experience difficulties or feel excluded, as this can help educators analyze barriers to participation and thereby promote inclusive education.

All things considered, there is no doubt that teachers do create a rich exposure for the development of vocabulary comprehension through various ways, including contextualized input, multisensory activities combining kinesthetic, visual, auditory, and tactile modes, as well as fostering meaningful connections with words. However, addressing learners' diverse proficiency levels in a way that allows all to be immersed in such meaningful experiences remains a persistent challenge.

4.2.2.3 Teachers' Strategies and Active Learner Processing

The results obtained from the interview shed light on the strategies teachers use to uncover how they support learners in becoming active processors and thinkers throughout their vocabulary learning process. The findings indicate that the participants guide learners in making sense of vocabulary through question formulation, sentence construction, or situational descriptions. However, the limited time allocated per session raises concerns about the feasibility and consistent application of such strategies.

To help anchor vocabulary meaning in learners' minds, teachers' responses to Questions 5 and 9 suggest that teachers commonly tie words to real-world usage, either through practical

questions and sentence creation, as one illustrated, “What is daughter?... I am your mother, and you are my daughter”; another added “What is your favorite hobby?” and mentioned dialogues, role-plays, and similar activities. This shows that their approach to Meaning-Making focuses on the communicative application of vocabulary, which corroborates Willis and Willis (2013, p. 4) who argue that meaning-based approaches encourage learners to use language actively, even when their output is not fully accurate.

The findings also demonstrate that teachers provide learners with opportunities to apply vocabulary in self-relevant contexts. For instance, one teacher has cited using family-related topics by asking such questions as “What is your father’s job?”, while another encourages learners to greet their relatives in English instead of their native language. In doing so, learners ground new vocabulary in their own personal realities, which supports the idea that each brain is shaped by individual experiences (Caine & Caine, 1991, p. 87).

At the core of such practices lies the time needed for learners to reflect on what they learn, and the data evince a clear awareness of this important aspect, mainly to check whether the vocabulary has been consolidated or begun to fade from memory. Teachers have reported using brainstorming, recapitulations, and assessments lasting from 10 to 15 minutes, as one stated, “…we start with a warm-up and sometimes use a diagnostic test to see if they really remember the last vocabulary lesson before moving on.” However, they have pointed to a major constraint, which is the limited instructional time that covers only 45 minutes per session, especially with class sizes of 40 learners. One of them has clearly expressed that, “Our didactic guide advocates for asking learners what they have learned either by giving an activity or asking questions, but I don’t always apply this for the lack of time.” These results are similar to those of Makuru, Pato, and Mashauri (2024, p. 9) who reported that 65% of their senior school teachers expressed dissatisfaction with the time designed for the English lesson. In this regard, Jensen (2005, p. 34) emphasizes that learning is complete not only when pupils understand and

express knowledge but also when they are able to retrieve and apply it later. In light of this, it becomes essential for policymakers to extend the session durations for learners to review and consolidate their learning, which in turn helps teachers better gauge learners' vocabulary progress.

In sum, the teachers' reported techniques actively engage learners in vocabulary comprehension and processing both personally and purposefully. However, the limited time stands as a significant barrier to fully implementing these strategies in a way that reaps their long-term benefits.

Taken together, the findings bring to light that teachers incorporate brain-compatible instructional strategies to varying degrees. Their practices notably align with *relaxed alertness* through a safe and playful environment that suits learners' characteristics. Even so, emotional and positive interactive engagement appear to be limited in both scope and consistency. In terms of *immersion,* their vocabulary teaching involves contextual, multisensory activities and encourages associative thinking. Nonetheless, adequately engaging learners of diverse proficiency levels in these experiences is deemed challenging. As for *active processing*, it is evident in strategies that promote meaningful and personal vocabulary use, though time constraints limit consistent reflection and consolidation. With that being said, the second research question, namely *"How often do Algerian fourth-grade EFL teachers integrate brain-based learning techniques when teaching vocabulary?"* is answered by confirming the second hypothesis advanced in the general introduction.

While some facets of BBL principles are absent from teachers' vocabulary instruction, a substantial range of techniques are clearly evident in their practices. In response to Question 1, none of the teachers reported intentionally aligning their instructional methods with insights from brain research. This indicates that, even without explicit awareness of this approach, many of their strategies are implicitly brain-compatible, reinforcing Djouaher's (2023) findings that

although teachers are not consciously aware of it, their practices appear to be guided by established teaching theories rather than applied randomly (see Section 1.2.2, Chapter 1).

Wilson, Romanaire, and Rethinasamy published a study in 2023 exploring ESL teachers' brain-based practices and perceptions in Malaysian schools. There are notable parallels that emerge from their findings and the present one, particularly in the use of cooperative learning, visual aids, and movement-based tasks. In both studies, teachers also activate learners' prior knowledge through strategies like role-plays and brainstorming, and offer varied, experiential learning opportunities to immerse learners in a rich experience.

4.3 Response to Research Question N#3: Compatibility of EFL Textbook and Teachers' Practices with Brain-Based Vocabulary Instruction

This section draws a comparative synthesis of the findings obtained from the textbook analysis and teacher interviews. In doing so, it also brings to light gaps in brain-based vocabulary instruction across both pedagogical sources.

4.3.1 Convergence and Divergence in Brain-Based Vocabulary Instruction

The analysis of both the EFL textbook and teachers' techniques reveals notable commonalities in their approach to Brain-Based Learning. More precisely, both sources make use of visuals as a shared technique to attract learners and convey meaning, thereby emotionally engaging them as one feature of relaxed alertness. Furthermore, the analysis of both results indicates that they teach contextualized vocabulary by placing it in texts and dialogues. Alongside this, they employ activities that stimulate learners through visual and auditory input, reflecting a shared reliance on contextual and multi-sensory techniques to immerse learners in meaningful experiences. These areas of convergence show an aligned approach toward brain-compatible instructional strategies, signifying that the textbook may serve as a supportive guide for teachers to plan and deliver their lessons (Rathert and Cabaroğlu, 2022, p. 171).

However, while both the EFL textbook and teachers' vocabulary instruction align with BBL in similar areas, they diverge in their choice and use of techniques. To begin with, the results reveal that the former provides cognitively engaging tasks followed by scaffolding to maintain a balance of challenge and support, whereas teachers tend to rely on group work to create a low-threat environment through shared task completion. In addition to this, the textbook engages learners emotionally mainly through pictures, while teachers use other strategies, including motivational classroom talk and competitive games that involve physical movement. Learner interaction is, likewise, elicited differently. That is, the material promotes it through structured dialogues, but teachers have reported using group or pair work that involves collaboration, role plays, and class competitions. There is also notable variation in how vocabulary is processed; where the textbook encourages learners to classify, categorize, and organize, teachers tend to apply communication-based tasks. Such divergence reflects the teachers' reliance on observing learners' needs, as evidenced in their responses to Question 1, where the majority have reported adjusting their practices based on pupils' feedback and reactions; it echoes the idea that each brain is uniquely organized, as stated in the analytical framework.

Importantly, these varied techniques do not reflect disconnection but rather complementarity, where the strength of one source can compensate for the limitations of the other. By way of illustration, the textbook supports kinesthetic learning through fine motor tasks. Teachers, by comparison, promote gross motor engagement through physical games, jointly activating the motor memory system. To support this point, it has been noted that "Children's kinesthetic development is directed at developing gross and fine motor skills" (Sadaruddin et al., 2022, p. 229). Thus, as indicated by Rathert and Cabaroğlu (2022, p. 173), *"teachers can select textbook materials as they are or adapt them to varying extents,"* both of which may enhance the implementation of Brain-Based Learning.

4.3.2 Identified Gaps in Brain-Based Vocabulary Instruction

The analysis of both the textbook content and teachers' practices reveals notable gaps in the application of brain-based learning principles. This section uncovers the limited or inconsistent areas in one source that may be addressed by the other, and then highlights aspects that are absent from both.

As discussed in previous sections, the analysis highlights that, in an attempt to immerse learners in vocabulary learning, the material provides limited opportunities for connecting new input to previously learned content. Similarly, there is little emphasis on linking vocabulary to learners' personal or individual experiences, an important component of active processing. In contrast, most teachers have reported offering their learners opportunities to make logical associations and apply new vocabulary to their own lives and preferences (e.g., "What is your favorite hobby?"). This mirrors Mayer's (2002, as cited in Pokhrel, 2022, p. 41) argument that textbooks can support learning, but they may not sufficiently engage learners in connecting what they learn to their experiences. Thus, teachers' practices can bridge certain limitations in the textbook's application of BBL. As one participant has stated, *"*I try to use tasks that are simpler than the ones of [sic] the textbook and sometimes more difficult to see how they can advance".

The findings further show that some aspects of brain-based vocabulary instruction are insufficiently supported by either source. To begin with, Relaxed Alertness is not entirely absent but appears to be reinforced in fragmented or limited ways. That is to say, both the textbook and teachers' practices do not fully engage learners emotionally, particularly in stimulating their curiosity. Moreover, interaction is either limited in form, such as the textbook's use of closed, scripted dialogues, or sometimes affected by negative social dynamics that hinder effective engagement in the classroom. With regard to Immersion in Complex Experiences, both instructional sources show limited responsiveness or difficulty in catering to

learners' different proficiency levels, since the analysis has revealed that the textbook restricts its techniques to lower- and moderate-level tasks, overlooking higher level learners, while teachers find it difficult to reach the diverse levels found in the classroom. With respect to Active Processing, reflective tasks are largely missing from the textbook units and are only sporadically applied by teachers due to limited instructional time in each session.

Altogether, the textbook and teacher practices reflect an alignment with BBL that is consistent in some areas of each instructional element, whether through shared techniques or through distinct methods that complement one another, while in others, connection to BBL remains either inconsistently reflected or entirely missing. As such, this responds to the third research question posed in this study, namely, *"How compatible are the fourth-year EFL textbook and teachers' practices with the Brain-Based Learning Approach?"* and supports the hypothesis proposed in the introduction.

Conclusion

This chapter has discussed the findings of the present empirical study through the lens of Brain- Based Learning elements and principles, as outlined by Caine, Caine, Klimek, and McClintic (2009). It has addressed the three research questions and their corresponding hypotheses introduced in the General Introduction based on the findings obtained from the analysis of a fourth-grade EFL textbook and teacher interviews. Taken together, these results not only answer the research questions but also provide insights into how BBL can inform vocabulary instruction in primary schools. This synthesis prepares the ground for the final part, which presents the overall conclusions of the study along with its implications and recommendations.

The present dissertation has investigated how the fourth-grade EFL textbook and teachers' strategies align with Brain-Based Learning (BBL) in the teaching of vocabulary. The study has been carried out with primary school EFL teachers, specifically at the fourth-grade level.

This study has pursued three main objectives. First, to examine how vocabulary components are presented in the textbook through the lens of BBL principles. Second, to explore how teachers approach vocabulary instruction in light of BBL principles. Third, to determine the degree of compatibility between the textbook and teachers' practices in terms of brain-based vocabulary instruction. To guide the analysis, the study has drawn upon the Brain-Based Learning framework developed by Caine, Caine, Klimek, and McClintic (2009), which encompasses three core instructional elements: relaxed alertness, immersion in complex experiences, and active processing. Each element is supported by a set of principles that explain and promote brain-compatible learning.

A qualitative research approach has been adopted, with data collected through textbook analysis and semi-structured interviews with EFL teachers from six different primary schools, all of whom teach fourth grade. The data have been analyzed through Qualitative Content Analysis (QCA).

The analysis of data gathered from the above-mentioned instruments demonstrates that both the EFL textbook and teachers' practices exhibit varying degrees of alignment with Brain-Based Learning (BBL). Specifically, both sources show reflection in some aspects of each instructional element of BBL based on the following evidence: In terms of Relaxed Alertness, the textbook employs visuals and scaffolded cognitive tasks to create a low-threat environment, while teachers foster a playful atmosphere and promote group work to maintain the challenge–support balance. Additionally, both immerse learners in complex experiences through contextual and multisensory activities. The textbook emphasizes fine motor tasks, whereas

teachers often integrate gross motor activities, as these can be complementary, supporting BBL to be more effectively applied. Regarding learners' processing, both sources encourage learners to engage with vocabulary meaningfully and cognitively, moving beyond rote memorization through tasks that involve either analysis (in the textbook) or communication (with teachers). Notably, some BBL-related aspects are more distinctly addressed in teachers' practices; for instance, connecting vocabulary to learners' personal experiences. However, the results reveal limitations as well: certain BBL elements receive inconsistent or limited attention in both the textbook and teachers' practices. This includes limited support for emotional engagement, as neither source actively stimulates learners' curiosity. It also concerns interaction, as the textbook relies heavily on scripted dialogues, and occasional negative social dynamics in classrooms are highlighted by teachers, all of which exhibit both the presence and absence of the defining features of *Relaxed Alertness*.

Furthermore, there is insufficient differentiation to address diverse learner levels, an essential component of *immersion in complex experiences*. Added to this, the absence of reflective or review tasks associated with *Active Processing*, which would allow learners to consolidate vocabulary meaningfully are largely unnoticed in the textbook and inconsistently implemented in classrooms, often due to time constraints. Therefore, this study holds implications that may inform textbook designers to revise vocabulary content in line with the suggestions highlighted earlier (see Section 4.1.2), guide teachers toward targeted training to address the identified gaps, and prompt policymakers to consider practical reforms, most notably, the extension of instructional time for a more effective implementation of brain-based vocabulary instruction.

Similar to all research, the present study has encountered a number of limitations. The most significant challenge was obtaining sufficiently detailed responses during the interviews, as some participants provided brief or general answers despite follow-up prompts. As a result,

collecting in-depth data proved difficult, and considerable effort was spent trying to extract information from them about teachers' practices. In addition, the small sample size of six teachers and the exclusive focus on the fourth-grade level limit the generalizability of the findings to other teachers or grade levels.

Notwithstanding these limitations, the present study provides valuable insights into vocabulary instruction in light of Brain-Based Learning, aiming to guide educators in identifying the strengths and weaknesses of their approaches. To further explore this area, I suggest that future research in the Algerian context could examine both the perceptions and actual practices of EFL teachers from a brain-based informed perspective, incorporating classroom observation. This would allow for a comparison between what teachers report and what they do in practice. Such research would either align with or contradict the findings of studies like the one referenced in Section 1.2.2 (chapter 1) by Bedilu and Degefu in 2022, who found that while teachers recognize the importance of applying strategies such as creating an anxiety-free environment, using multisensory tools like realia and flashcards, and limiting translation, their actual practices often rely on explanation, word definition, and translation into the mother tongue.

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Appendices

Appendix A: The Textbook Analysis

➢ Relaxed Alertness

The dimensions	Task Evidence	The extent of presence
Emotional engagement	Structured dialogues at the end of each sequence: *p.47; p.62; p.85* ..	Clear - Clear - Partial
Challenge- Support balance	Word search task/ pictures: school subjects /objects. *U3, p.45*	Clear - Partial
Interactive engagement	Fill-in-blank: visual support/ word choices. *U4, p.52*	Clear
	Word search: images indicating pain areas. *U4, p52*	Clear - Partial
	Select correct word for each image (games/celebrations) *(U7, p.75)*	Clear - Partial
	Match animals to their babies. Use of pictures and an example. *U8, p.82.*	Clear - Partial
	Discover, color, and name animal species (cat, sheep…) from illustrations. *U8, p.83*	Clear - Partial

➢ Immersion in Complex Experiences

The dimensions	Task Evidence	The extent of presence
Contextual learning	Read the conversation and match: characters /nationality. *U1, p.18*	Clear - Clear
Connection to prior knowledge	Listen and fill in blanks with word *options (e.g., "This is my uncle. He is a ___"): carpenter, saw etc. U2, p.29.*	Clear - Clear Clear - Clear

Multisensory engagement	Use words from text and options to complete sentences .*U2, p.32.*	Clear- Clear
High- Complexity	**Listen and match furniture to locations *U2, p.42***	Clear - Clear Clear
Moderate- complexity	**Listen to a conversation and tick symptoms: fever, cough, etc.*U4, p.50.***	Clear - Clear Clear
Lower-Complexity (no color)	Listen and complete food baskets: visuals and word cues. (U5, p.57)	Clear - Clear Clear
	Read and link food items to the health problems they may cause (U5, p.60)	Clear – Clear Clear
	Extract job/sport vocabulary from text (U6, p.68)	Clear – Clear Clear

- **Active Processing**

The dimensions	**Textbook evidence**	**The extent of presence**
Meaning making	Design a personal family tree and name each relative *U1, p.12*.	Clear - Present
Reflective Pause before New Input	design a school map using target vocabulary *U3, p.38.*	Clear
Flexible input for personal Processing	Expand a list of school subjects and objects using prior knowledge. U3, p.45.	Clear - Clear
	Classify food into ‘healthy’ and ‘unhealthy’ baskets. U5, p.58	Clear
	Classify words as ‘fish’ or ‘cheese’ using image clues. U5, p.60	Clear
	Cross out the odd animal in each group. *U8, p.92.*	Clear

Appendix B: Teacher Interviews

All interviews were audio-recorded with the participants' consent, so the answers reported in this study are based on those recordings and were transcribed verbatim. It is important to mention that the respondents have shifted between English, French, and their native language (Kabyle). Thus, the transcriptions presented in this study reflect the original language used by the informants, when necessary, translations into English are provided.

Dear Teachers,

First of all, thank you for agreeing to take part in this interview. Your participation is appreciated. The purpose of this interview is to explore the techniques you use when teaching vocabulary to fourth-grade EFL learners, and to examine the extent to which these techniques reflect the instructional elements and principles of Brain-Based Learning (BBL). To achieve this goal, you are kindly invited to respond to a series of questions related to your classroom practices. Please note that all your responses will be used solely for academic purposes, and your confidentiality will be fully respected.

- ***Interviewer:*** how do you incorporate knowledge of the brain and its functioning into your vocabulary teaching methods?

Teacher 01: Well, the brain is important, but no, not really. We take into consideration more the learning styles, but the brain no, … we don't get into those details. I just know that their way of thinking and their way of assimilating is different.

Teacher 02: It is important but I don't really look for these things. That's all [laughs] I can say.

Teacher 03: It is interesting I guess but honestly I don't really try to get information about the brain… but of course, the brain is related to learning… How? ur nezri ara (we don't know). I just pay attention to the learners, I use observation, I also try to study the learner all over the year… each one with its strengths and weaknesses.

Teacher 04: Wow, the brain… that's, I don't know, important maybe! because when you know how it functions, you can guide your learners, especially for the young learners, but not really… I don't get this knowledge into … or try to teach with the brain knowledge. Honestly, how I can say it, … the situation here does not really help. Like, we barely have time, so to apply things like brain research and all that, circumstances are not encouraging.

Teacher 05: When teaching, and as you said, vocabulary, we are far from the brain or how it functions and relate it to the methods, … On remarque des choses en class (we notice things in class); for example, we know that learners differ from others… donc je me base sur ce que j'vois, voila (so I base my teaching on what I see).

Teacher 06: All I know; it is related to psychology which is useful for teaching but I don't use techniques by looking at the brain or its function.

- ***Interviewer:*** How do you encourage learners to put effort into vocabulary learning without inducing stress or fear?

Teacher 01: For this, I ask them to work in groups and help each other. For example, in a session called 'I learn and enjoy', they participate what they have learned during the previous session through games, group works etc. For example, I put the different learners … j'essaie de mettre le bon, [le] moyen, et le faible dans un groupe (I try to group the top learner with the average and the low-level ones), so there is of course a challenge between the different groups as a competition. All the learners participate, even the shy [ones].

Teacher 02: I try to accept their answers, I encourage them to participate even if it could be the wrong answer, not blame them… I say you have the right to make mistakes, and I'm here to help you.

Teacher 03: I encourage them to learn more at home. In the class, I make them work in groups, and I select the brilliant pupils and the slow or weak to have each other in one group, … so I mix them and each one takes the idea of another. When the brilliant one gives their idea, it will

be clearer for the others, so sometimes I give them the chance to help his [or her] friend. We also have a session for role plays, a session of 45 minutes to practice.

Teacher 04: As a first point, I do my best for them to get the idea that we learn from our mistakes. I do this before starting to work together, and I make sure not to blame them… I have never blamed them, and it is successful.

Teacher 05: I encourage them to make more efforts, to learn more at home as a homework… do[ing] research. I use group tasks, where we have games, so they learn without being afraid, ou stressés (or stressed).

Teacher 06: I use puzzles, or concurrences (competitions) between two groups, there is this sense of competition, so every group tries to give their best. Then of course, we praise, reward, or provide positive feedback to make them feel they are progressing.

- ***Interviewer*:** if you view peer collaboration as an important aspect of vocabulary learning, could you please share how you usually foster interaction among learners in your lessons?

Teacher 01: I create games, I let them work in groups aken imdenniɣ lina (as I told you previously). For example, the group with more points, i.e. score, will win the game, in this way all member of [the] group will try to learn and give their best. They make efforts, … it's a kind of excitement at the same time. For the interaction, I also use conversations and dialogues.

Teacher 02: I use pair works and group works, this helps them interact.

Teacher 03: I think it is the same answer I will give you… sometimes group work for competitions and sometimes pair work. At the end they are rewarded, so they are amusing at the same time they are learning. For the pair work, I use dialogues and research work, donc dagi adesfehmeɣ; par exemple, (so here I will explain; for instance,) I give them words and they have to search them letter by letter to get the full structure.

Teacher 04: For interaction and peer collaboration, I use mainly the TPS: think, pair and share. For example, in a task, they work in a group of two learners, they think…this means each one thinks alone, and when they finish, they share and exchange their thoughts, then we're going to fin or form the vocabulary that is related to the lesson, … and something else is… if the activity is easy or simple, I use a pair work, but if it's a set of activities, we form a group of three or four learners. But to be honest, I don't use it a lot because some of them do not help make the group successfully doing the task, they prefer to give their own answers without collaborating.

Teacher 05: Again, I use group work by selecting the members, so they think first, then each one will give their ideas, and when they finish they exchange… either in group or just two learners (TPS). Sometimes it gets too messy so I try to have a leader for every group to organize them.

Teacher 06: I will say one more time that I use group work too for the aim of enhancing interaction, especially when they play against each other as challenge, in other tasks, I try to make them repeat together, … a choral repetition.

- **Interviewer:** How do you take into account learners' emotions when designing the vocabulary lessons?

Teacher 01: In planning my lesson, I choose appropriate flashcards, songs and attractive materials, again games and competitions, all these are part of their interests and motivation. There are some learners who respond through visuals, and others through auditory [modes] *etc.* But I can say that I rely mainly on flashcards for finding it interesting for almost all learners, since they are young and love colors… that's it.

Teacher 02: I use games like tic-tac-toe to reinforce vocabulary in a playful way, and role plays too they love it but I personally avoid it because the class becomes too noisy and cannot be controlled.

Teacher 03: I use realia, bring toys, school facilities: you know that I did teach them outside the classroom and then asked them where is canteen? Where is the headmaster's office, staff room? ...etc. I have made a tour with them, we see trees, I ask them touch it and name it. We also make theatres, sometimes, I remember when I've brought couscous with me to use it in [a] role play.

Teacher 04: Emotions are very important, especially in primary school where learners are young. We should vary in tasks to avoid boredom, I mean to teach and reinforce the vocabulary using different ways, plus I use characters that are familiar with them, … I give ah... use examples from their own environment and experiences.

Teacher 05: First, I take into account how learners' reaction and interaction be, so I design the lesson based on their minds, by bringing a song, pictures and flashcards.

Teacher 06: I… try to find ways to make it sound easy to remember, … and I use gifts, gift cards for them, but… learners' emotions, I don't know how to answer this honestly.

- **Interviewer:** Do you teach vocabulary as isolated words or in relation to others? If both, how do you integrate them?

Teacher 01: For the fourth grade, I display pictures to support the comprehension of vocabulary used in the text. For example, what do you think? what do you see? So I use the text where there is the target vocabulary. I extract words with my learners and try to teach them in relation to other words directly.

***Teacher* 02:** I start with isolated words using flashcards, then I try to connect [them] to other words by creating sentences using these words.

Teacher 03: For the new vocabulary, I try to teach only the words being isolated or single, using words plus pictures, or realia and gestures *because some words need pictures, others gestures, or real objects... to transmit the meaning*. I use a list of vocabulary starting from simple to difficult, where we break them down *to help pupils understand how it is written and*

pronounced, then I give tasks from the textbook or in a worksheet at the end, where they learn these words in sentences.

Teacher 04: That's a good question because I need to say something about it. Before, I used to teach isolated words, but after gaining an experiences, I realized that I need to include those words in sentences or texts for them to store the meaning, … and indeed *learners understand better when vocabulary is in the contex*t.

Teacher 05: I use questions like 'what is daughter?', if it is not clear, I put it in an answer like 'I am your mother and you are my daughter'.

Teacher 06: I start teaching the words being isolated then I put them in a sentence and in a text… to understand the word in context.

- ***Interviewer:*** How do you incorporate multisensory activities into vocabulary instruction?

Teacher 01: we try to include our hands, body language, facial expression in leaning. I ask them to touch their parts whenever they hear a word from me. I use games like the one of 'Simon says 'touch your nose' they touch their nose if they understand the word… and what else, … I make my learners mime the vocabulary meaning through songs. I actually select games where there is [sic] physical responses, so they move, they act, the run… etc. They are active.

Teacher 02: I use objects to touch, for example, a computer, I … also bring food or snacks to touch, smell and even eat just to practice.

Teacher 03: Okay, so I use, let's say, a competition in form of TPR between one boy and one girl, …I bring a learner to state the name of a vegetable, then the two other learners will have to compete and touch the word, like potato, first.

Teacher 04: I mainly use games, where learners are doing something by listening to an audio or by working in visual flashcards.

Teacher 05: for sensory techniques, I use a lot the hearing [mode], the listen to words then this can be followed by a task to complete or a game to do. It depends. I use puzzles, where they move here and there to order the words.

Teacher 06: Learners learn through feelings, so I use 'TPR' total physical response in different tasks and different ways, including games and role plays for different learning styles.

- ***Interviewer:*** How do you adapt your vocabulary teaching approach to accommodate the varying abilities and proficiency levels of learners?

Teacher 01: group work helps me in this matter… I select different learners' levels and abilities and also, dans le cours (during the lesson) I focus on the slowest and struggling learners. I give attention to all learners, but more chance to these learners specifically. I believe group work is also effective in such case, I also prepare my lesson by using bloom's taxonomy… In the assessment, I focus on the slow learners too to see their progress, to see their progress and weaknesses, so this way we will know whether to move on or use another way to clarify.

Teacher 02: It's something we know, and … hard if I may be clear, but I try by giving them other challenging tasks to the advanced [learners], and for the slow, I try to help by giving less difficult tasks when teaching. I also, sometimes, use bloom's taxonomy.

Teacher 03: well, I can't say that I deal with all the levels successfully, but I try as much as possible. For example, I use repetition with every struggling learner, to, for example, focus on their pronunciation and explain what the word means if needed, ah... I give more illustrations, gestures and I use the native language for the weak pupils… I want to say again that It is very hard to manage these differences, but we try our best to simplify.

Teacher 04: yeah, this is called differentiation, and I do try to have all my learners focused by… maybe sometimes I use choral repetition to make them all participate but I do focus on those who are shy or afraid to see if they get the word and its pronunciation correctly… I am very familiar with my learners, so I can focus on them while they blend in with the group,

without drawing attention or making them feel embarrassed since some … are also shy, but still… the challenge that we still face, as teachers I guess is to make them all learn in a sufficient way in every session.

Teacher 05: I use gestures, I use the word in context, and interaction, but if it still does not work, I tell other pupils to explain to their friend. Honestly, it is very difficult to manage these differences, but we try our best to simplify and …for learners with higher proficiency, we give them some challenging questions to figure out. And … I do assessments to see their progress and weaknesses, so this way we will know whether to move on or use another way to clarify.

Teacher 06: I try to repeat teaching and explaining to that category to make sure they understand if time allows, and sometimes I use the mother tongue.

- ***Interviewer:*** When it comes to connecting newly introduced vocabulary with previously learned items, in what ways do you support your learners to form meaningful associations?

Teacher 01: Since the lessons in each unit have the same theme, so yeah it is important to connect the previously learned words with the present ones by using those learned vocabulary to teach something else.

Teacher 02: Yes, we have to link, for example, to teach the verb 'eat', let's assume they have vocabulary about food, so I bring a snack or burger then I use it to teach 'eat'.

Teacher 03: For example, if I take the unit of food where learners already learned about chocolate and candies, and ... let's say... today's lesson is on health problems, I try to link them … for example, when you eat a lot of chocolate and candies, you get a toothache or a stomachache, and the same thing for the other units.

Teacher 04: let's say unit one is about healthy and unhealthy food, and unit two is about unhealthy problems. To teach vocabulary of health problems, I need to use the vocabulary learned about unhealthy food. The sequences are related and this helps us do this connection.

Teacher 05: To teach new vocabulary, I make them remember the one learned last year for example, so I try to remind them of the vocabulary they learned. I taught them pets todays, but I tried to start by asking them about animals they know and learned last year. So …we consider it as [consecutive lessons]; for instance, last year they learned the vocabulary for parts of the face, so this year we teach [the learners] other parts of the body by connecting it to what they already know.

Teacher 06: I try to connect the vocabulary learned in the last year to introduce the new one since they are, how to say, des cours en continu (continuous lessons), and even between sequences, we try to link the vocabulary learned at first to teach the new one found in the second sequence.

- ***Interviewer:*** If you go beyond rote memorization, what are the methods that you use to ensure that learners internalize vocabulary meaningfully and personally?

Teacher 01: I use drilling, but as another technique I use words in context through different tasks. I ask the about things related to their own lives and preferences like what is your favorite hobby? or What is your father's job? he is a teacher; she is a teacher. etc.

Teacher 02: I try to make them memorize with meaning in different ways, like repetition, memorizing in pairs, using role plays, dialogues and games.

Teacher 03: I encourage them to use the words that we have learned, for example, greeting their family members in English at home instead of their native language. Say good night, good morning my father, my mother…etc.

Teacher 04: I encourage them to express using that vocabulary because it is the most successful method to make it stored in their brain and know in which contexts they can use it.

Teacher 05: I actually use pictures and ask them, look at this and find out what is it? Another example is: when you are sick or have fever, you go to…? Who? [to elicit] the word "doctor".: you go to the doctor! I also say, you are my pupils and I am your …? I am your teacher!

Teacher 06: I use pictures to make the vocabulary clear. We teach more about understanding the word than memorizing it, so they technically use it in some simple sentences.

- ***Interviewer:*** If you recognize the importance of reflection in vocabulary teaching and learning, how do you guide your pupils in consolidating what they have learned before or after instruction?

Teacher 01: Our didactic guide advocates for asking learners what they have learned either by giving an activity or asking questions but I don't always apply this for the lack of time. No time for activities honestly, but I try to ask some questions about what they have learned

Teacher 02: I erase the lesson from the board to ask them what they have captured, I ask them to use slates for some questions at the end of the session, but the problem is the 45 minutes, knowing that the class consists of 40 learners. So, I try to design a whole session for a role play to practice all what they learned throughout the unit. Assessment and teaching go hand in hand to see their progress.

Teacher 03: If there is enough time when we finish the lesson, I give them a chance to think about what they have learned by using an activity in a sort of competition, … or game.

Teacher 04: Based on my experience, it is very important because when they are repeating and responding at that moment, … they… it's easy for them to do that, but we should know if they really retain the vocabulary meaningfully or not. So, for me, at the end of the lesson, I leave some time to the learner to see what they remember. If there is not time, I give them a homework, and in the next session we correct it together. Same thing, at the beginning, I do a warm-up to refresh the memory and try to make sure it sticks in their mind.

Teacher 05: The last 10/ 15 minutes is [sic] for recapitulation and assessment, we always have to finish the session with a task… In the next session, we start with a warm-up and sometimes, use a diagnostic test to see if they really remember the last vocabulary lesson before moving on. What we can add… I use brainstorming a lot, … [and] at the beginning of a session, I ask

them to remind us of the last vocabulary lesson … if, at the end, there is a sufficient time, we try to summarize or use an activity in a sort of game.

Teacher 06: I use tasks, last 10 minutes as a quick task with slates.

- ***Interviewer:*** To end, would you mostly rely on the textbook, or do you incorporate your own techniques?

Teacher 01: I sometimes use the textbook, but also other sources, from internet or by discussing with colleagues, so we share ideas and techniques. Lan kra les trucs, nsexdamithen mais pas tous (there are some things in which we use the textbook, but not all of it).

Teacher 02: I definitely use other sources, especially to prepare some highly-challenging tasks to see the level of my learners. So, I get techniques depending on the level and objective of the lesson using other sources from internet such as Facebook channels.

Teacher 03: Textbook guides me, but I don't rely on it most of the time. It is not enough on its own, so we need other things, other activities to clarify the lesson or vocabulary more to the learners. Sometimes, I try to use tasks that are simpler than the ones of the textbook and sometimes more difficult to see how they can advance.

Teacher 04: yes of course I do, I use sources from internet like websites that are plenty of activities, so I select and accommodate them for my learners, some difficult to increase the level and some simple to make it clear.

Teacher 05: For the textbook, I use it for tasks and example, c'est un guide quand-même (it's still a guide, after all), but I use my own technqiues according to the learners' level. I pick up ideas and accommodate.

Teacher 06: sometimes I use the textbook for exercises, but we always incorporate our own methods such as the use of flashcards and word search games to teach vocabulary. In fact, there are many things in the textbook that don't match the curriculum, donc yella anda yelha (so it's effective in certain situations).