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THE ASSOCIATION BETWEEN VARIANCE IN WORKING MEMORY CAPACITY AND FOREIGN LANGUAGE RECEPTIVE AND PRODUCTIVE LEXICAL KNOWLEDGE

The Case Study of Master One Students of English as a Foreign Language— University of Frères Mentouri Constantine 1

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Dedication

To my mother and father,

for their deep affection and endless support.

To my dear sisters Soumia and Dounia, my brother Yasser,

for their encouragement and joyful company.

To all my friends and colleagues.

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ABSTRACT

Acquiring a satisfactory level of vocabulary knowledge is a prerequisite for mastering any language. It is a complex and continuous process that recruits several cognitive faculties, particularly memory mechanisms. The working memory is a memory concept that plays a vital role in the processing, manipulation and retrieval of information. The present study sets out to examine the association between the working memory capacity and vocabulary comprehension and use among students of English as a Foreign Language based on the frequency levels of words' occurrence in the language. To achieve such a purpose, four widely used tests were administered: two vocabulary tests and two working memory capacity tests; the tests were taken by a randomly chosen sample of (40) Master One students of English as a Foreign Language enrolled at the Department of Letters and English—University of Frères Mentouri Constantine 1. The scores obtained from the vocabulary test, the Vocabulary Size Test, that assesses the subjects' abilities to recognize and comprehend words—receptive lexical knowledge—were compared with their scores in the working memory capacity test, the Reading Span Test, that measures their abilities to comprehend and recall words. Similarly, the scores obtained from the vocabulary test, the Productive Vocabulary Levels Test, that assesses their abilities to use words—productive lexical knowledge—were compared with the scores they obtained in a working memory capacity tests, the Speaking Span Test, measuring their abilities to retain and reproduce words in sentences. Moreover, two questionnaires were delivered to teachers and students to determine their level of awareness and perceptions of the implications of cognitive and psychological abilities in language learning, with heavier focus on the link between vocabulary and memory. A high correlation ($r_1= .59$) was found between the working memory capacity to recognize words and receptive lexical knowledge. In parallel, a high correlation ($r_2= .73$) was achieved between the students' working memory capacity to retain and reproduce words and productive lexical knowledge. The questionnaires revealed a high level of awareness among both teachers and students of the significant role of various cognitive and psychological processes in vocabulary building. Furthermore, the working memory functioning was found to be highly implicated in vocabulary comprehension and use.

Keywords: Receptive vocabulary knowledge, productive vocabulary knowledge, word frequency, Working Memory capacity

LIST OF ABBREVIATIONS

ADHD: Attention Deficit Hyperactivity Disorder

BNC: British National Corpus

CA: Correct Answers

CE: Central Executive

EFL: English as a Foreign Language

fMRI: Functional Magnetic Resonance Imaging

Gc: Cristallized Intelligence

Gf: Fluid Intelligence

LOP: Level of Processing

LTM: Long Term Memory

LTS: Long-Term Store

L1: First Language

L2: Second/Foreign Language

M: Mean

min.: minute(s)

MIT: Multiple Intelligences Theory

N: Number

NA: No Answers

PMA: Primary Mental Abilities

PVLT: Productive Vocabulary Levels Test

r: Correlation Coefficient

RST: Reading Span Test

SD: Standard Deviant

sec.: second(s)

sig.: Significant

STM: Short Term Memory

SST: Speaking Span Test

STS: Short-Term Store

TOEFL: Test of English as a Foreign Language

VLT: Vocabulary Levels Test

VST: Vocabulary Size Test

WA: Wrong Answers

WM: Working Memory

WMC: Working Memory Capacity

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1. Background of the Study

The present research work is based on intersecting insights and assumptions emanating from research endeavours conducted in interrelated disciplines including cognitive psychology, neurology, educational psychology, developmental psychology, experimental psychology and language education to deepen our understanding of the relationship between language acquisition/learning and cognitive processes. Particularly, the implication of human memory processes in the development of lexical knowledge.

2. Statement of the Problem

It stands to reason that growth in vocabulary knowledge is vital to language mastery whether it is a first, second or a foreign language. Language education research accentuates the importance of attaining a satisfactory level of lexical proficiency to successfully comprehend and use the language. Therefore, an adequate level of lexical knowledge is deemed a contributory factor to the development of language learning skills (listening, speaking, reading and writing), as well as to the achievement of linguistic and communicative competences. Furthermore, lexical development is an endless process that basically entails the accumulation of a massive and complex knowledge of words, knowledge of a manifold, changing and growing nature. Put differently, knowing a word is not limited to its form and meaning but a number of aspects such as collocation, grammatical behaviour, the frequency of occurrence in the language, use and register. Additionally, it is divided into receptive and productive knowledge as two fundamental dimensions.

From a cognitive perspective, lexical development is a significantly sophisticated process; it involves creating and enlarging lexical schemata (networks) or what is referred to as a mental lexicon through constant exposure to the linguistic input. Such an elaborate process depends upon a variety of mental abilities namely perception, recall, rehearsal, retention, recognition and handling of informational knowledge. In consequence, it recruits a

multiplicity of interconnected cognitive processes including intelligence, reasoning, attention, decision-making, problem-solving and memory.

Evidently, memory is a prerequisite cognitive mechanism that underlies the acquisition and development of lexical competence. A considerable body of research has been undertaken to understand the nature and mechanisms of human memory. As a result, several distinct models have been devised, each of which is assumed to have particular properties and perform particular information-processing operations. The most salient models conceptualized in research involve: the Short-Term memory (STM), the Long-Term memory (LTM) and the Working Memory (WM).

The working memory (WM), first proposed by Baddeley and Hitch in 1974, is a construct that performs highly complex cognitive functions such as processing, manipulating, encoding, rehearsing, retrieving and maintaining information. It plays a pivotal role in treating information received from both STM and LTM. Accordingly, the Working Memory Capacity (WMC) is believed to influence a wide range of educational activities: ranging from language skills, to comprehension, to mathematical reasoning and problem solving. Furthermore, it is implicated in various learning difficulties and deficits; for instance, Attention Deficit Hyperactivity Disorder (ADHD), Dyslexia, and reading disorders. Therefore, researchers in educational psychology consider the WMC as a useful measure of learning potential and a powerful predictor of performance across a myriad of learning tasks, particularly language learning.

In our foreign language learning classrooms, it is assumed that a considerable number of students recurrently encounter the problem of the paucity of lexical knowledge; this is reflected in their unsatisfactory performance on a diversity of language learning tasks and activities such as writing productions, engaging in conversations in the Target Language (TL) and comprehending texts. Such an issue is presumed to relate to the WM functioning and

shortcomings. Thus, regarding the significant pertinence of the WM operating systems to educational attainment, the questions that arise here are:

- How is the WM functioning implicated in the process of foreign language lexical development?

- To what extent do EFL students vary in their lexical competence and WMC?

- To what extent do differences in WMC among students correspond with their receptive and productive lexical knowledge?

- Do students utilize their WMC potentials efficiently?

3. Aims of the Study

Growth in word knowledge is an evolving process that inevitably relies on multiple cognitive mechanisms, namely memory. Presumably, The WM operating mechanisms match the requirements of achieving lexical competence, namely word recognition, comprehension and production. That is to say, directing attention, encoding, rehearsing, retaining, retrieving lexical units are all information-processing operations that could be attributed to the intervention of the WM. Ergo, our study aims to examine the relationship between the WM functioning and the process of vocabulary building among EFL learners and the extent to which potential differences in WMC among students could determine the fluctuation in their lexical proficiency levels. Moreover, the study sets out to enquire the extent to which teaching and learning activities, within our learning/teaching environment, optimize the WM functioning in vocabulary growth.

4. Hypotheses

On the basis of the assumed relationship between WMC and lexical knowledge among learners of English as a foreign language, we hypothesize that:

- the working memory mechanisms affect EFL students' lexical proficiency and development;

- individual differences in working memory capacity among EFL students are strongly related to their receptive and productive lexical knowledge with regard to the degree of the frequency of words' occurrence in the TL texts.

5. Means of Research

The investigation of the relationship between the WMC and lexical competence is twofold: a correlational study (quantitative study) and a questionnaire (qualitative study). The correlational study embraces two widely used sorts of testing carried out within the same settings: a vocabulary assessment and a working memory capacity measurement taken by a randomly chosen sample of Master 1 students of English as a Foreign Language enrolled in the Department of Letters and English language—University of Frères Mentouri Constantine 1. The vocabulary assessment comprises two tests; each test focuses on one dimension of lexical knowledge. The first, the Vocabulary Size Test (VST), is primarily used to assess word recognition and comprehension (receptive vocabulary knowledge). The second, the Productive Voabulary Levels Test (PVLT), mainly targets lexical production (productive vocabulary knowledge). Equally, the working memory measurement also involves standardized tests of the WMC: the Reading Span Test (RST) and the Speaking Span Test (SST). The former mainly measures one's ability to recognize and comprehend and recall verbal material through reading (receptive), whereas the latter measures the ability to retain and produce verbal stretches (productive). Eventually, a Pearson product-moment correlation is carried out to determine the strength of the association between the WMC measurement and vocabulary assessment. A correlation coefficient (r_1) is calculated to find out the strength of the association between the scores of VST (receptive vocabulary knowledge) and RST of WMC; similarly, a second correlation coefficient (r_2) is worked out to determine the strength of the association between the scores of PVLT (productive vocabulary knowledge) and SST of WMC.

Additionally, as a complementary research tool, two open-ended questionnaires are designed for teachers and students within the aforementioned department to elicit their awareness of the role of memory as well as other related psychological and cognitive constructs in optimizing EFL students' academic performance and achievement.

6. Structure of the Study

The study is made up of six chapters. Chapter One reviews the most prevailing learning theories established in the field of educational psychology, with a particular focus laid upon the cognitive approach which serves as a groundwork of the study. Chapter Two scrutinizes the fractionation of human memory and the working memory in particular based on empirical research findings and assertions. Equally, it discusses the WM system: the concept, theories, models, functioning, assumptions about individual differences in WMC and its measurement, and the implication of WM in academic achievement. Chapter Three sheds light on the complex nature of both the process and concept of vocabulary learning and acquisition: its dimensions and paradigms of assessment for research purposes (testing learners' vocabulary knowledge and their use of vocabulary learning strategies). Chapter four presents the results obtained from the analysis of the data yielded by the administration of the four tests and the correlational study .Chapter five illustrates the results and discussions of the questionnaires designed for both teachers and students. Chapter Six suggests a set of pedagogical implementations, stemming from lexically based enquiries and instructions as well as assumptions about the role of cognition in language learning that enumerate effective ways of boosting WMC functioning and promoting vocabulary development in foreign language learning classrooms.

Chapter One

Major Learning Theories

Introduction

Learning is an elusive concept that has long been explored from a wide range of perspectives including philosophy, psychology, neurology, sociology, and education. It involves a myriad of processes and mechanisms that might shape how one acts, responds to, and be influenced by the surrounding environment. Educational psychology is a scientific discipline that basically strives to gain an in-depth understanding of how learning occurs and what it involves. It draws on theoretical and empirical findings generated in interrelated disciplines specifically including cognitive psychology and language education. Therefore, a plethora of intersecting perspectives has led to the formulation of a number of prevailing theories, each of which rests on distinct sets of assumptions regarding the process of learning. First, the behaviourist approach focuses on the association between behavioural phenomena and environmental factors as part of the learning process. Second, the cognitivist approach emphasizes the importance of mental processes such as insight, perception, attention, problem-solving, decision-making, memory, intelligence, and language as contributory factors to the construction and application of knowledge. Third, the social approach rests on the belief that individuals learn through interacting with other members of a particular learning community.

1.1. Historical Background of Psychology

The history of psychology dates back to times of ancient Greeks. The term psychology is derived from a combination of two Greek words 'psyche' and 'logos'. The former refers to 'soul', while the latter means 'science'. Thus, psychology might be defined as the 'science of soul'. However, such a definition is limited to something purely abstract and metaphysical, for it cannot be observed or be subject to scientific experiment. In the 18th century, psychology was regarded as 'the study of mind' or the science of mental processes; nonetheless, the term *mind* remained a source of ambiguity. By the 19th century, psychology

came to be known as 'the study of consciousness and inner experiences'. However, the broadness of the concept 'consciousness' has fuelled much controversy among scholars. In the 20th century, which is recognized as the era of modern psychology, the definition of psychology has been further refined into 'the study of human behaviour and experience'. This definition primarily encompasses activities that can be enquired scientifically. Nowadays, psychology includes several branches that basically focus on the rational study of what humans do and how they think. One of the major areas to which a vast amount of psychological knowledge is applied is education through the branch known as educational psychology.

1.2. The Scope of Educational Psychology

Typically, educational psychology is the branch of psychology that is concerned with human learning processes. Sharma and Sharma (2006) stated that "educational psychology makes a psychological study of human development, maturity and learning, and applies the scientific conclusions of this study to actual teaching conditions to attain the ends of education." (p. 13). They added that educational psychologists investigate mental processes and the changes that occur in individuals' behaviours as consequences of undergoing various stages of development from childhood to adulthood via interacting with the environment.

Educational psychology is deemed a normative science that attempts to provide rational descriptions and explanations of individual differences in behaviour, intellect, personality and self-concept. The field depends on empirical findings yielded by testing, assessment, measurement, evaluation and training to optimise scholastic achievement and the learning potential. Dalvi (2014, p. 104) indicated that "educational psychologists are working side by side with psychiatrists, social workers, teachers, speech and language therapists, and couselors in an attempt to understand the questions being raised when combining behavioural, cognitive and social psychology in the classroom settings."

Educational psychology intersects with multiple disciplines including philosophy, sociology, cognitive psychology, neuroscience, biology, medicine and pedagogy. It equally informs various specialities within the educational arena such as instructional design and classroom management, the enhancement of educational technology, learners' needs analysis, curriculum design, organizational learning, and coping with students with special needs and leaning deficits. Furthermore, it addresses a wide range of topics pertinent to the learning process and behaviour including memory, intelligence, affect and language from a variety of theoretical perspectives: psychodynamic, behavioural, humanistic, psychological and cognitive. The following table outlines different key perspectives about learning established in the field of educational psychology

Table 1.1. Five key perspectives in the psychology of education (Long, 2000, p. 4)

Perspective	Overview
Psychodynamic	An approach developed in the early twentieth century from the work of Freud. Mainly considers emotional development, and is applied in therapeutic approaches for children with problems, and for deriving general educational objectives (e.g. Coren,1997).
Behavioural	Learning theory, based on observable behaviour and developed by the psychologists Pavlov,Watson and Skinner . Although rather less popular these days, it does generate powerful techniques for analysing and modifying behaviours in school.
Humanistic	Emphasises the uniqueness and potential for self-development of individuals. Developed by Maslow to counter the mechanistic perspectives of psychodynamic and behavioural psychology, it underlies child-centered approaches in education.
Psychobiological	Considers that basic biological structures and processes determine higher-level thought and action. A key concept in issues of nature/nurture such as the basis of intelligence and the processes which underlie arousal and motivation.
Cognitive	Sees the individual as a processor of information, setting up an internal model of the world and developing plans and strategies to guide ways of interacting with it to achieve goals. *The most recent and productive of all the different approaches;* it can account for many of the findings and ideas in the other perspectives and applies to virtually every topic of educational study.

1.3. Major Learning Theories

In layman's terms, the word *learning* refers to acquiring an amount of knowledge or certain skills. Though such a definition seems rational, learning is a broad term that remains, to the present time, one of the most critical issues within the scope of educational psychology. Abundant research endeavours are still attempting to decipher the intricacies of such a complex process. As a result, the conception of learning has undergone momentous shifts driven by the constant change in theoretical perspectives that established a number of different findings, each of which is based on particular assumptions and empirical studies about the mechanisms and the outcomes of the process. In the field of educational psychology, to have a deeper understanding of the process of learning, a broad taxonomy of learning approaches or frameworks based on different theoretical orientations has been established; these primarily include behaviourism, cognitivism, social learning, and cultural learning. Evidently, there is an overlap between these approaches, but there is no reason to favour one over another. Wildman (2008) stressed that all the frameworks provide "an important window on learning and allows us to see human learning as the rich multifaceted phenomenon it really is" (p. 574).

1.3.1. Behaviourism

Behaviourism, or the behaviourist approach, is an influential conceptual framework that dates back to the late 19th century. It is a systematic approach that scrutinizes learning in terms of the behaviour of animals and humans. Pritchard (2008) emphasized that the fundamental principles underlying this approach are the association between observable behaviour (responses) and environmental events (stimuli), in addition to the consequences of rewards and punishments in the reinforcement of the way one acts. Behaviourists generally ignore any mentalistic explanations based on thinking processes, and essentially consider environmental factors affecting behavioural changes in organisms. Jordan, Carlile and Stack

(2008) stated that "behaviourists define learning as a relatively permanent change in behaviour as the result of experience. This change in behaviour is always observable, with some behaviourists proposing that if no observable change happens, no learning has occurred." (p. 21). Commonly, behaviourists contributed to the understanding of learning through the study of what is called *classical* and *operant conditioning*.

1.3.1.1. Classical Conditioning

According to Glassman and Hadad (2009), the history of *classical conditioning* extends back to the work of the Russian psychologist Ivan Pavlov by the turn of the 20th century. Pavlov's famous experiment with dogs to understand the process of digestion provided foundational insights about the interrelation between stimuli and responses as part of learning. In his experiment, Pavlov noticed that dogs can salivate in the presence of food. The food is referred to as an "unconditioned stimulus", while the salivation is termed an "unconditioned response"—an automatic reaction that many species possess including humans; for example, reactions to hot surfaces or sudden noises. Afterwards, Pavlov started ringing a bell (a "conditioned-stimulus") just before the food had arrived. He found out that after a number of trials, the sound of the bell alone could induce salivation, which was known as a "conditioned response". As such, Pavlov is said to have conditioned dogs to salivate, a behaviour modification known as *classical conditioning*. However, if the conditional stimulus (the ringing bell) is repeatedly introduced without the presence of unconditional stimulus (the food), the conditional response (salivation) decreases to the point that it may be extinguished (also called "*extinction*").

Shortly after Pavlov's work, in 1925, the American psychologist John Watson, a pioneering figure in the field who coined the term "behviourism", carried out a similar well-known experiment on an eleven-month infant named "Albert". According to Long (2000), Watson associated a loud frightening noise with the appearance of a white rat that Albert did

not previously fear. In doing so, the appearance of the rat alone, after a number of repetitions, was sufficient to frighten the infant. Therefore, the loud noise classically conditioned the behaviour of Albert to manifest anxiety and fear as a response to the appearance of a white rat. Eventually, Albert's fear was generalized to white rabbits and furry toys, a state that was called "stimulus generalization". Accordingly, classical conditioning is regarded as an incentive factor of fears and phobias.

In a word, the significance of classical conditioning in behaviour is that it permits to adapt to the environment through anticipating environmental events.

1.3.1.2. Operant Conditioning

Operant conditioning, also known as *instrumental conditioning*, is another sort of associative learning advocated by behaviourists. It dates back to the 1930s, based on the approach structured by the American psychologist Burrhus F. Skinner who investigated the impact of reward and punishment on the reinforcement of behaviour. Long (2000) clarified that operant conditioning rests on the assumption that one's behaviour is determined by the consequences of his acts. That is to say, the strength of the association between acts and their consequences is determined by reinforcement or punishment. Thus, if an act that leads to desirable consequences is positively reinforced (rewarded), it is highly likely that the frequency of its re-occurrence increases. For instance, a mother who gives her son a praise or gift for doing homework may encourage him to sustain such a habit. Conversely, if an act that brings about unwanted or an aversive outcome is negatively reinforced (punished), there is a high probability that its frequency of re-occurrence decreases. For example, if someone climbs a tree and gets hurt, he may not climb a tree thenceforth.

The behaviourist approach dominated from the 1930s up to the 1960s in psychological studies. In the meanwhile, it received heavy criticism, for it concentrated solely on external behaviour while ignoring the cognitive aspects and genetic makeup that were believed by

many scholars to have much to do with the process of learning. As a result, alternative views were put forward resulting in the emergence of newer approaches.

1.3.2. Cognitivism

Weinstein and Acee (2008) defined *cognition* as "thinking and the mental processes humans use to solve problems, make decisions, understand new information or experiences, and learn new things." (p. 164). The cognitive approach, or shortly cognitivism, is a theoretical framework established in psychology that regards learning as information processing. By the late 1950s, psychologists started raising questions about what goes on in one's mind to find out how humans process and store information as characteristic features of the learning process. This shift in focus, that reached its momentum in the 1970s, was recognized as the *cognitive revolution*; it was stimulated by reactions against behaviourits' neglect of the fact that learning depends on intellectual or mental processes such as perception, reasoning, memory, building schemas, problem-solving, decision-making, intelligence and language. Jordan et al (2008) pointed out that

> Behaviourists came to realize that not all learning could be explained by Pavlov's and Watson's theories of simple stimulus-response and reinforcement. In 1927 Köler demonstrated that apes solved problems through a form of thinking he termed 'insightful behaviourism'. Neo-behaviourists such as Tolman expanded this mental focus to consideration of purposive behaviour in animals and people. He demonstrated that rats build up a mental representation or cognitive map of their environment and develop expectations rather than a set of inflexible links between stimuli and response. (p. 37)

Wildman (2008, p. 576) summarized the fundamental issues that motivate cognitive enquiry. First, it is crucial to explore the active nature of information processing, and to uncover the capacities and limits of memory. Second, as far as acquisition is a focal point in

cognitive enquiries, it is indispensable to comprehend the structure and organization of memory. That is, as long as learners continually construct knowledge, how is it mentally represented? Third, learners require taking control over their learning, so it is essential that people should be adequately aware of their own learning. Fourth, learning is not conceived as a linear process during which people incrementally add to their knowledge; rather, it is a cyclical process of constantly going back to already established concepts that need to be refined or adjusted for misconceptions.

1.3.2.1. Piaget's Theory of Cognitive Development

The Swiss psychologist Jean Piaget (1886-1980) was one of the most influential figures in the field of cognitive psychology. He conducted a long-term scientific study examining the way in which children construct knowledge, a pioneering work that laid the foundations of cognitive development research. According to Oakley (2004, pp. 16-23) Piaget postulated that children, from birth to about the age of 16 years undergo a hierarchical sequence of four cognitive developmental stages. Each stage is characterized by a particular way in which the child figures out and interprets the world. They basically include:

1- *The sensory-motor stage* (birth to 2 years): this stage lasts from birth to the start of language acquisition. At the beginning, infants interact with the world via reflexes such as 'the sucking reflex'. Afterwards, the infants start to depend on sensory motor activities through linking experiences (e.g. sight and touch) with physical interaction to explore the world and learn what they are capable of doing. By the end of the stage, they acquire an ability to imitate and integrate information to build knowledge of the world. A 2 years old child can use objects to refer to other objects; for instance, using a cup to represent a boat in a game. Furthermore, a key characteristic feature of this stage is the development of the concept of 'object permanence'. That is, infants become aware of the existence of objects even though

they cannot see them (out of the field of vision). This implies that they have developed mental representation of objects.

2- *The pre-operational stage* (2 to 7 years): this stage involves two phases, the *pre-conceptual* phase and the *intuitive* phase. Firstly, the *pre-conceptual* phase (2 to 4 years) is a phase featured by a boost in language development, the use of symbols and internal representations, and the reliance on imagination. Besides, the children's thinking is constrained by egocentrism— children perceive the world only from their perspectives and barely understand other perspectives. Secondly, the *intuitive* phase (4 to 6 years) is characterized by acquiring an ability to mentally classify objects (e.g. animals).

3- *The concrete operational stage* (7 to 12 years): during this stage, children develop strategies to mentally operate on concrete things. For example, a child can solve problems they can notice or manipulate.

4- *The formal operational stage* (12 to 16 years): is the final stage in which the reliance on concrete objects decreases as children start to think abstractly. Accordingly, children become capable of using deductive reasoning (thinking in logic) to solve hypothetical problems in a systemic manner.

1.3.2.2. The Major Cognitive Processes

The primary mental processes scrutinized in cognitive research works as interlinked contributory factors impacting learning mainly include: insight, perception, memory, forgetting, reasoning, problem-solving, decision-making, intelligence and language.

1.3.2.2.1. Insight

According to Glassman and Haddad (2009) the term 'insight' was first coined by the German psychologist Wolfgang Kohler who argued against the behaviourists' emphasis that learning is a matter of trial and error. After a number of experiments during which Köhler observed that animals could use insightful behaviour to do a particular task, he concluded that

they organize experience in a particular way. Thus, the term insight refers to "a sudden change in the way one organizes a problem situation, typically this is characterized by a change in behaviour from random responding to rule-based responding." (p. 165).

1.3.2.2.2. Perception

Perception is a mental process that significantly contributes to information processing and knowledge construction. Esgate and Groome (2005) described perception as a process through which "we make sense of our surroundings by interpreting the information from our sense organs.Perception progresses from sensation (i.e. the intake of information by the sense organs) to the higher-level cognitive processes that are performed on that information." (p. 13). This suggests that perception is an initial stage of information processing that entails extracting meaning from a received sensory input—sight, hearing, smell and taste—in an attempt to interpret or make sense of the information that it contains. In addition, the Types of perceptions are tied to the type of the sensory organ engaged; these include: visual perception connected with sight (perceiving shapes, calours and light), auditory perception relation to hearing (detecting sounds and vibrations), and haptic retention tied to recognizing objects by touch. Taste perception has to do with perceiving the falvour of food (e.g. sweetness, bitterness, sourness, and saltiness).

By way of making a link between perception and cognition (thinking), Galotti (2004) distinguished two types of perceptual processing to organize knowledge: the bottom-up processes and the top-down process based on the assumptions of the Gestatlt theory. The term *bottom-up* process (or *data-driven*) essentially means that the perceiver starts with small bits of information from the environment that he combines in various ways to form a percept." (p. 64). This means that an individual perceives individual parts or pattern of an object and puts them together into a whole for recognitions. *Top-down* perception, on the other hand, refers to perceiving an object as a whole and, then, the individual parts or features to make sense of the

input. It is driven by experience and affected by the context in which the object is encountered. For instance, one can understand odd handwriting when reading complete texts, but it can become harder to understand when reading the words of the sentence in isolation.

1.3.2.2.3. Memory and Learning

Opposite to the behaviourists' view of learning as an association made between stimuli and responses, cognitivists consider learning as a process of gathering and organizing information in a form of mental schemata that recruits a number of mental processes, particularly memory. In broad terms, memory refers to the ability to store and remember information. In psychological studies, since the 1930s, memory has been a thoroughly investigated concept, notably by cognitive psychologists. The major issues under scrutiny have concerned how information is stored, processed, retrieved, organized and/or lost from memory. Radvansky (2017) referred to memory as "the mental process used to acquire (learn), store, or retrieve (remember information) of all sorts." (p. 1). Similarly, Sternberg (2009) defined memory as "the means by which we retain and draw on our past experiences to use that information in the present. As a process, memory refers to the dynamic mechanisms associated with storing, retaining, and retrieving information about past experience." (p. 177).

Nonetheless, the conceptualization of memory cannot be wrapped up in a single definition. It is worth considering that memory involves a number of processes such as encoding, storage, rehearsal and retrieval of different sorts of information: visual, auditory, haptic, gustatory, and so on. In addition, research works undertaken to explore memory mechanisms have resulted in several theoretical frameworks or models. Each model is made up of several integral components, has a specific operational system, and characterized by a certain capacity and duration.

Sternberg and Sternberg (2012) proposed a widely accepted mode in which informational knowledge is dealt with by memory processes. Initially, new information received from the environment (input) is encoded through perception and attention. Afterwards, an encoded piece of information is rehearsed (silently or loudly recited) to keep it active. However, not all information is successfully rehearsed; that is, information can be consolidated or stored if rehearsed adequately, otherwise it will be lost (forgotten). Finally, stored information is often retrieved (recalled) to cope with future situations (output).

The first formal model of memory dates back to 1968. It was proposed by Attkinson and Shiffrin under the name the *modal* model. Baddeley (2012) explained that the first model comprised three basic processes or stores: the sensory store, the Short-Term Store (STS) and the Long-Term Store (LTM). The sensory store is responsible for processing information detected in the environment by sensory organs. The STS, that was later renamed as the Short-Term Memory (STM), is a limited-capacity component which holds a small amount of information (a maximum of seven items or chunks) for a brief period of time (about 15 seconds). The LTS, later called the Long-Term Memory (LTM), is a component of an unlimited-capacity that stores information for long, sometimes permanent, periods of time. The modal was widely accepted as a rational framework, but it has undergone further refinements. In 1974, Baddeley and Hitch introduced a new more dynamic component referred to as the Working Memory (WM). They argued that the first model was simplistic and provided superficial evidence regarding how information is processed, manipulated and retrieved from LTM. Thus, the WM acts as an interface between the STM and LTM in that it processes, manipulates and retrieves all sorts of information.

1.3.2.2.3.1. Forgetting

A more fruitful way to understand how memory functions is to investigate the phenomenon of forgetting or memory loss. It is generally understood as the failure to recall

information. Cognitive psychologists have distinguished two theories about forgetting: when information is permanently lost, or when information is already retained but cannot be accessible or retrieved. The former theory is applied to forgetting in STM, while the latter is applied to LTM.

Glassman and Hadad (2009) provided a number of clarifications about the two types. They postulated that information at the first stage of memory, the sensory memory, is transient and highly likely to decay if it is not selected by attention for transfer to STM. Forgetting in STM is attributed to its limited capacity. That is, new incoming information tends to supersede a previously encountered one. This is called *displacement*. This latter is often caused by interference or the effects of distractions. For instance, being interrupted by someone when trying to recall a piece of information makes the task harder, and displacement is therefore highly likely to take place. However, resisting forgetting may be enhanced by means of some mnemonic techniques such as elaborative rehearsal, recoding information and meaningful chunking (transforming meaningless items into meaningful chunks for better recall). Forgetting in LTM, on the other hand, is caused by different factors. As previously noted, information could not be retained unless it is transferred from STM to LTM. Baddeley (1999) hypothesized that informational knowledge stored in LTM becomes difficult to remember due to a factor called *interference*—as the store of information grows in LTM, it becomes harder to quickly identify an item. Interference takes two forms: retroactive interference (acting backwards) and proactive (acting forwards) interference. The former refers to the impact of recent experiences on one's ability to recall material learned earlier. The latter has to do with the inability to learn and recall information as a result of influence of prior experience. Finally, forgetting may occur due to other factors such as sleep, ageing, brain damage and psychological trauma that are all believed to be contributory factors in memory disorders and deficits.

1.3.2.2.4. Reasoning

Reasoning is a mental process that is inextricably intertwined with thinking and cognition; in many references, it is used interchangeably with thinking. Reasoning has much to do with the ways in which information is represented and processed in the mind to make judgments and decisions. In addition, it is interrelated with other mental faculties such as memory, problem-solving, decision-making, intelligence and language. Sternberg (2009) defined reasoning as "the process of drawing conclusions from principles and from evidence. In reasoning, we move from what is already known to infer a new conclusion or to evaluate a proposed conclusion." (p. 499). That is, reasoning is one's ability to determine or judge the validity of a conclusion in accordance with evidence and premises. Research in cognitive psychology has identified two primary types of reasoning: inductive reasoning and deductive reasoning.

1.3.2.2.4.1. Deductive Reasoning

Deductive reasoning is defined as "the process of reasoning from one or more general statements regarding what is known to reach a logically certain conclusion." (Sternberg & Sternberg, 2012, p. 507). It refers to the case when one uses a stated premise or propositions to draw conclusions that can logically be inferred from it. For example: 'John is older than Franscesca (premise1). Joseph is younger than Franscesca (premise 2). Therefore, John is older than Joseph (conclusion).' Groome (1999) emphasized that "deductive reasoning entails problems for which a normative solution is available, namely that required by the logical systems, and the subjects' responses can be measured as either correct or incorrect against such a criterion." (p. 107). This implies that the conclusion to be drawn about a given statement can be either deductively valid or fallacious.

1.3.2.2.4.2. Inductive Reasoning

Secondly, inductive reasoning is recognized as "the process of reasoning from specific facts or observations to reach a likely conclusion that may explain the fact. The inductive reasoner then may use that probable conclusion to attempt to predict future specific instances." (Sternberg & Sternberg, 2012, p. 519). A key characteristic that differentiates inductive reasoning from deductive reasoning is that the conclusion to be drawn from a statement can be well-founded but not necessarily true; that is, it is based on the notion of testing the validity of a hypothesis which may lead to a logically sound conclusion but not, in all cases, certain. For instance: 'pigeons are birds; pigeons can fly (hypothesis), so birds can fly (conclusion)'. In the example, the conclusion seems plausible but uncertain with the existence of flightless birds such as 'penguins' and 'ostriches'.

Galotti (2008) pointed out that reasoning is influenced by many factors including one's previous experiences, existing knowledge and prior beliefs which may bias reasoning, and thus result in poor evaluations and judgments. Furthermore, neuroscience research revealed that reasoning involves brain areas related to WM, notably the prefrontal cortex and basal ganglia. This suggests the interdependence between the two cognitive constructs.

1.3.2.2.5. Problem Solving

One of the fundamental aspects of thinking and cognition is the ability to use information to deal with situations that involve some sort of obstacles, or what is referred to as problem solving. Research works into cognition have addressed key aspects of problem solving; for instance, how can problems be defined and categorized? What sorts of techniques do individuals employ to cope with different problematic situations?

Glassman and Hadad (2009) defined problem solving as "the process of determining appropriate actions in order to overcome obstacles that interfere with reaching a desired goal." (p. 191). Likewise, Reeds (2000) stated that problem solving is "a mental process that involves discovering, analyzing and solving problems. The ultimate goal of problem-solving

is to overcome obstacles and find a solution that best resolves the issue." (p. 71). This implies that problem solving refers to an effortful cognitive activity of using strategies at one's disposal to possibly remove obstacles encountered on the path to a solution.

Researchers have argued that solving problems effectively requires approaching the situations in a systematic way; that is, individuals ought to undergo a set of determined plans or strategies to achieve the desired goal. Sternberg and Sternberg (2012, pp. 445-446) described a number of basic stages, termed *the problem-solving cycle*, which a person should go through in order to solve a problem efficiently; these include:

1- *Problem identification*: Do we actually have a problem?

2- *Problem definition and representation*: What exactly is our problem?

3- *Strategy formulation*: How can we solve the problem? The strategy may involve *analysis*—breaking down the whole of a complex problem into manageable elements, […] the complementary process of *synthesis*—putting together various elements to arrange them into something useful. […] *Divergent thinking*—you try to generate a diverse assortment of possible alternative solutions to a problem. […]. *Convergent thinking*—to narrow down the multiple possibilities to converge on a single best answer.

4- *Organization of information*: How do the various pieces of information in the problem fit together?

5- *Resource allocation*: How much time, effort, money, etc., should I put into this problem?

6- *Monitoring*: Am I on track as I proceed to solve the problem?

7- *Evaluation*: Did I solve the problem correctly?

1.3.2.2.6. Decision-making

One more cognitive process that has attracted considerable interest in the cognitive research arena is the way individuals make decisions. It is closely related to the processes of reasoning, problem solving and memory in that it is deeply involved in using informational

knowledge to make plans, choices, judgments and evaluations in regard to different situations. Galotti (2008) stated that "cognitive psychologist use the term *decision-making* to refer to the mental activities that take place in choosing among alternatives. […] Typically, decisions are made in the face of some amount of *uncertainty*." (p. 459). Equivalently, Sternberg (2009) pointed out that "judgments and decision making are used to select from among choices or to evaluate opportunities." (p. 480). Research has accordingly focused on the strategies that guide making decisions as well as the major factors that influence such a process.

To make proper decisions, Sternberg and Sternberg (2012) argued that people use different sorts of heuristics—"mental shortcuts that lighten the cognitive load of making decisions." (p. 490). Nevertheless, making decisions is always an error-prone process. Tversky and Kahneman (2002) discussed various types of heuristics used by people to make judgments. First, *representative heuristics* have to do with judging things or events on the basis of the degree they represent or reflect the main features of a particular prototype stored in one's memory. Second, *availability heuristics* are related to making judgments about things in terms of how quickly relevant information about a situation can be retrieved from memory in order to make a decision. Retrieval of information is affected by how recent the event is (recent events are fresh in memory, and thus more retrievable), how unique it is (information about distinct events are more retrievable), how accurate it is (doing something several times increases the likelihood that the same solution is used in future situations). Third, *intuitive heuristics* refer to making judgments and decisions based on intuition rather than systematic reasoning. This tendency results from the confirmation of one's beliefs about the accuracy of information known about something and lack of explaining failures; it may prove counter-productive if the accuracy of such information is overestimated, and consequently leads to making biased judgments or poor decisions. Fourth, *framing* is another factor considered in decision making; it concerns the way an issue is framed affects the decisions. Likewise stated,

the options at one's disposal are thought to significantly affect selecting one option. An example of the faming effect was provided by Sternberg and Sternberg (2012, pp. 496-497):

> we tend to choose options that demonstrate risk aversion when
> we are faced with an option involving potential gains. That is,
> we tend to choose options offering a small but certain gain
> rather than a larger but uncertain gain, unless the uncertain gain
> is either tremendously greater or only modestly less than certain.

Fifth, one more cognitive tendency, that significantly impacts decision making, is recognized as *belief bias*. To illustrate, one's pre-existing beliefs have the likelihood to distort logical reasoning leading to ill-founded decisions. Furthermore, drawing on the same beliefs recurrently may result in belief perseverance and more rigid thinking.

To promote decision making, as Sternberg (2009) indicated, cognitive psychologists have suggested a range of techniques that make thinking more flexible and improve decision making; these include, promoting convergent thinking—giving precise answers to given questions, divergent thinking—a sort of reasoning that permits 'free thinking' to possibly come up with several equally convenient solutions to a given issue. Galotti (2008, p. 493) concluded that

> Despite all the literature documenting people's errors in
> judgment and decision making, people do make decisions every
> day. It is therefore worth remembering that any good theory of
> decision making must explain how people have survived thus far
> and where the sources of people's competence lie. At the same
> time, it is probably safe to conclude that complex and important
> decisions can usually be made more carefully.

In brief, gaining a deeper understanding of the factors and mechanisms that influence the process of decision making allows coming up with fruitful methods that sharpen up people's skills of processing and using information.

1.3.2.2.7. Intelligence

Intelligence is one of the most mysterious and controversial cognitive constructs; it is unquestionably important to learning, for it is implicated in the performance on highly complex cognitive tasks. In addition, it is interrelated with other mental faculties including reasoning, problem solving, memory and language. Research works intended to demistify such an enigmatic entity continue, to the present day, to find out what exactly is meant by intelligence, and how one person differs from another in terms of intellectual abilities and growth. Nonetheless, it is important to realize that no consensus definition of the concept has been reached. Gottfredson (1997, p. 18) provided an elaborate definition illustrating that intelligence refers to:

> A very general mental ability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surrounding— "catching on,", "making sense" of things, or "figuring out" what to do. (pp. 14-15).

The above definition seems rational and captures a number of aspects which have been so far attributable to intelligence. However, the attempts to conceptualize the workings such an elusive construct as human intelligence have led to converging and diverging theories and models built upon different assumptions, empirical support, and distinct views of the development of intellectual capacities and applications. What they have in common is the objective of adequately describing, explaining and testing intelligence.

1.3.2.2.7.1. The Contemporary Theories of Intelligence

As indicated earlier, intelligence is an elusive construct that is difficult to define, explain and measure. Accordingly, a variety of frameworks and theories about intelligence

have been formulated. Davidson and Kemp (2011) pointed out that "fully and indisputably understanding this elusive construct can fairly identify and cultivate it." (p. 58). That is to say, gaining an in-depth understanding of intelligence is a promising enterprise for individuals and sciences to develop it. They equally illustrated that intelligence is currently defined on three levels: psychometric, psychological and social.

1.3.2.2.7.1.1. The Psychometric Level

In essence, psychometric models of intelligence scrutinize individual differences across individuals on the basis of their performance on mental tasks. Besides, the scores of individuals on such tasks are compared to determine the overall structure of intelligence.

1.3.2.2.7.1.1.1. General Intelligence

One of the most influential theories of intelligence is the *general intelligence theory,* or the *g factor theory* put forth by the statistician Charles Spearman in 1904. According to Mackintosh (2011), the theory considers that intelligence is a unitary construct rather than a multi-component one. In 1904, Spearman conducted an experiment on children in a village school administering a battery of tests to measure their mental abilities such as sensory discrimination, arithmetic computations and vocabulary, as constituents of their "cleverness in school" or "sharpness and common sense out of school" (p. 6). Then, he used a factor analysis as a statistical procedure to compare the scores obtained by his subjects, and to find out the extent to which they correlated. Finally, he postulated that subjects who score highly in one area tend to score highly in other areas. Therefore, the performance of every individual on such a test battery could determine his or her overall intellectual abilities referred to as *general intelligence (g)*, a common factor to predict academic outcomes in various areas.

1.3.2.2.7.1.1.2. The Theory of Primary Mental Abilities

The Primary Mental Abilities (PMA) theory is a widely accepted intelligence theory in the cognitive research literature. It was proposed by the American psychologist Louis

Thurnstone. Mackintosh (2011) explained that Thurnstone's work was a reaction against Spearman's view of intelligence as a single unit. In 1938, Thurnstone argued that there are a number of independent primary mental abilities; these include seven factors: verbal comprehension, verbal fluency, spatial reasoning, perceptual speed, numerical ability, inductive reasoning and memory. Further, a test battery that bears the theory's name (PMA) was designed to test each distinct mental ability.

1.3.2.2.7.1.1.3. Fluid Intelligence vs. Crystallized Intelligence Theory

Jordan et al (2008) asserted that the British psychologist Raymond Cattel divided the g factor of intelligence proposed earlier by Spearman, into two distinct but related factors: the fluid intelligence (Gf) and the crystallized intelligences (Gc). Gf has to do with the speed of mental processing of new information, whereas the Gc refers to the use of already acquired knowledge and skills. Davidson and Kemp (2011) assumed that "Gf involves mentally working well with novel information, and it is dependent on the efficient functioning of the central nervous system." (p. 60); conversely, "Gc consists of the set of skills and information that individuals acquire and retain in memory throughout their lives." (p. 60). In the same context, Gf is believed to be strongly linked to the individual's genetic make-up as well as biological factors. In contrast, Gc is assumed to mirror environmental impact; for instance, the level of education and socio-economic status. Mackintosh (2011) asserted that "Gf was seen as the biological basis of intelligence, and Gc as the expression of that ability in the accumulated knowledge acquired as a result of exposure to a particular culture." (p. 10). Dai (2008) made a distinction between the two sorts of intelligence; on the one hand, Gf refers to "the ability to manipulate complex information and detect patterns and relations interpreted to have direct biological underpinnings […] and declines with aging." (p. 537). On the other hand, Gc is defined as "the cumulative effect of experience and education." (p. 537). Furthermore, cognitive research has developed a test battery known as the Woodcock-

Johnson test (W-J III) designed measures of the two factors based on the assumptions of the theory.

1.3.2.2.7.1.2. The Psychological Level

Theories falling under this category primarily focus on the relationship between the activity of the brain and mental intelligence. That is, they basically attempt to probe into the neural basis of intelligence.

1.3.2.2.7.1.2.1. Brain Efficiency and the Parietal-Frontal Integration Theory

Advancement in neuro-imaging technologies such as the Functional Magnetic Resonance Imaging (fMRI) has offered significant findings about the functions of the brain and how complex mental processes locate in different brain regions. The parieto-frontal integration theory singles out a network of integral brain regions linked to individual differences in general intelligence and theory. Davidson and Kemp (2011) claimed that, as the name of the theory suggests, these brain regions are located in the parietal and frontal lobes, and they are responsible for integrating informational knowledge from other brain regions. They presumed that "the attributes of general intelligence are not associated with one central part of the brain but with a network of structures and functions distributed throughout the cortex." (p. 64). What is more, highly intelligent people are considered to have larger cortical networks that operate more efficiently than less intelligent ones.

1.3.2.2.7.1.2.2. The Neural Plasticity Model of Intelligence

The neural plasticity model of intelligence is another theory that is founded on findings in neuroscience about the link between the brain and intelligent behavivour. Cronin and Faota (2016) reported that the theory rests on the concept that intelligent people tend to possess a brain that productively re-adjusts itself in response to environmental changes and demands; they stated that "in this model, differences in intelligence are due to inherent differences in brain plasticity, the brain's capacity to for neural adaptation […] the most

highly intelligent individuals have dynamic neural networks that alter their composition in order to accommodate task demands."(p. 107). Correspondingly, Davidson and Kemp (2011) indicated that "neural plasticity allows synaptic connections between neurons to develop, change, and reorganize in response to environmental stimulation." (p. 65). This implies that the surrounding environment has the effect of creating and enlarging neural connections that are needed to cope with the cognitive demands that it imposes.

1.3.2.2.7.1.3. The Social Level

Intelligence theories falling under this category shed light on the social efficiency of intelligence. They regard intelligence as an active system which associates interrelations between mental processes, contextual influences, and diverse abilities recognized in and out of academic settings.

1.3.2.2.7.1.3.1. Sternberg's Triarchic Theory of Successful Intelligence

The eminent American psychologist Robert Sternberg proposed a multi-dimensional concept of intelligence labelled the successful intelligence theory. According to Sternberg (2009), the theory comprises four basic elements:

● "Element 1: intelligence is defined in terms of the ability to achieve success in life in terms of one's personal standards, within one's socio-cultural context" (p.76).

● "Element 2: one's ability to achieve success depends on one's capitalizing on one's strengths and correcting or compensating for one's weaknesses." (p. 78).

● "Element 3: success is attained through a balance of analytical, creative, and practical abilities." (p. 78).

● "Element 4: balancing of abilities is achieved to adapt to, shape, and select environments." (p. 78).

Above all, Sternberg (2013) asserted that his theory is founded on the significance of analytical, creative and practical abilities to mental functioning. Accordingly, these three

fundamental aspects largely contribute to the application of intelligence not only to academic circumstances but also to society. First, analytical abilities involve the analytical skills that allow individuals to make evaluations, judgments and critique of information. Second, creative intelligence has to do with generating new ideas, solving newly faced problems, and rapidly automatzing procedures (acquired ways of doing things). Third, practical abilities entail forging links between individuals' skills and their surrounding environments which permits applying ideas in the real world.

1.3.2.2.7.1.3.2. Multiple Intelligences Theory

In the early 1980s, the American psychologist Howard Gardner rejected the conventional view that intelligence is a unitary construct. He argued that individuals possess a combination of at least eight distinct intelligences unique to every individual. Moreover, many of the widely used standardized intelligence tests, such as the IQ (intelligence quotient) measures, are thought to provide a narrow view of the intellectual abilities across individuals. Gardner (1999) defined intelligences as "a biopsychological potential to process information that can be activated in a culture to solve problems or create products that are of value in a culture." (p. 33). Gardner's assumptions came to be recognized as the *multiple intelligences (MI) theory*. It delineated eight types of intelligences that people use throughout their lives individually or cooperatively within particular cultural settings: linguistic intelligence, mathematical/logical intelligence, bodily/kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence, naturalistic intelligence, musical intelligence, and spatial intelligence.

Mckay (2008) summarized the definition and characteristics of each sort of intelligence within Gardern's theory.

1- *Linguistic intelligence*: a type of intelligence featured by "the sensitivity to languages, including the ability to learn languages to achieve goals." (p. 712). It primarily refers to the

capacity to use language effectively through an adequate manipulation of all language components: phonology, syntax, semantics and pragmatics. People that manifest linguistic adeptness tend to be creative writers, poets, orators, politicians, humourists, teachers, translators and journalists. In addition, linguistic intelligence might possibly be improved through listening to recordings of well-known speakers, reading and retaining poetry and prose.

2- *Mathematical/logical intelligence*: "the ability to solve problems logically, complete mathematical problems quickly, differentiate logical or numerical patterns, and conduct scientific inquiry." (p. 713). Mathematical/logical intelligence obviously depends on problem-solving processes, analytical and abstract thinking. People demonstrating a high level in such a type of intelligence often excel in mathematics, statistics, philosophy, physics, chemistry, engineering and computer programming. Activities that may enhance mathematical/logical intelligence usually include playing math and logic games, quizzes, and learning computer language.

3- *Bodily/kinesthetic intelligence*: "the ability to expertly control one's body movements and the ability to skillfully handle objects." (p. 713). Individuals who have a well-developed bodily/kinesthetic intelligence are remarkably adept at using their body parts to create items and solve problems. It depends on balance, reflexes, coordination, flexibility, dexterity and expressiveness. Such abilities are well-developed among dancers, athletes, acrobats, comedians, actors, artisans and surgeons. Example activities that can promote bodily/kinesthetic intelligence might comprise swimming, practising gymnastics, yoga, doing drama or performing in theatre.

4- *Interpersonal intelligence*: "the ability to accurately evaluate the moods, intentions, thoughts, feelings, and motivations of other people." (p. 714). This type of intelligence entails the skilled use of body language, gestures, verbal cues and facial expressions to interact with

other people. Professionally, interpersonally intelligent people may include teachers, political or business leaders, salesmen and actors.

5- *Intrapersonal intelligence*: "the ability to access and understand one's own internal experiences, including a range of emotions, and to draw on internal experiences as a means of making decisions about, and guiding, one's behaviour." (p. 714). Intrapersonal intelligence has to do with the notion of self-concept and the ability to manage one's instincts, emotions and drives to meet one's needs. Careers suited with intrapersonally intelligent people might involve teaching, psychology, political and spiritual leadership. Additionally, intrapersonal intelligence can be promoted through such activities as meditation, psychotherapy and counselling.

6- *Naturalistic intelligence*: "the ability to recognise and classify different species of flora and fauna in the environment." (p. 715). As the name implies, this type is related with the understanding of nature; notably, the ability to distinguish different types of animals, plants, and geographic features of regions in the natural world. A typical example of a person possessing such abilities is the British naturalist Charles Darwin. The works of Darwin to classify and describe a myriad of species of animals, plants and fossils in his long expeditions around the world proved such an intellectual gift. By the same token, people who are highly likely to be naturalistically intelligent are botanists, gardeners, geologists, veterinary doctors, biologists and etymologists.

7- *Musical intelligence*: "auditory imagery (the ability to mentally hear musical tones), and the ability to hear, recognize, and manipulate music." (pp. 715-716). Musically adept individuals tend to demonstrate considerable abilities to interpret and harmonise tone, rhythm and tune. This type of intelligence can be found among performers, compositors, music educators and instrument makers. Likewise, musical intelligence can be fostered by attending musical performances or having an eclectic music taste.

8- *Spatial intelligence*: "the ability to recognize and manipulate areas of space. Specifically, […] the capacity to perceive the world accurately and to transform initial perceptions through mental rotation." (p. 716). Accordingly, a person having a high level of spatial intelligence often manipulates large-scale mental images; for he or she can sharply perceive things in space which other people can probably miss. Equally important, it requires a deep understanding of shapes, colours, dimensions of objects, and a distinguishable sense of visual arts. Illustrative examples of people that demonstrate such giftedness may involve sculptors, painters, photographers, architects, designers, navigators and pilots.

Last but not least, the theory of multiple intelligences is still widely accepted in the cognitive research literature as a reasonable explanation of how people differ from each other in intellectual abilities. It is also applicable to both academic and social circumstances. Notwithstanding, it lays more emphasis on domains of intelligence rather than on the mental operations that underlie these differences.

1.3.2.2.8. Language

At the core of cognitive enquiry, language is regarded as a paramount mental faculty for it heavily depends on information processing. In its broader sense, language involves a complex process of acquiring, developing and using a system of codified symbols to learn and communicate information. Glassman and Hadad (2009) defined language, from a cognitive psychological perspective, as "a system of communication based on symbols or gestures which can vary across individuals and allow for new forms and meanings." (p. 201). Sternberg and Sternberg (2012) provided a more elaborate definition. They stated that

> language is the use of an organized means of combining words in order to communicate with those around us. It also makes it possible to think about things and processes we currently cannot see, hear, feel, touch, or smell. These things include ideas that may not have any tangible form. (p. 360).

Drawing on insights from linguistics, psycholinguistics, neuropsychology, Second Language Acquisition (SLA), cognitive psychologists attempt to decipher the intricacies of language processing and development. Their works principally focus on understanding the basic components of language; recognition, comprehension, and production of both written and spoken forms of language, learning languages other than the mother tongue. In the same vein, they attempt to explore how language relates to other mental faculties.

1.3.2.2.8.1. The Componential Structure of Language

Evidently, mastering a language requires an adequate manipulation of several components that serve as the building blocks of the entire system: letters, sounds, words, phrases, sentences and texts. An important step to take to understand language, in its spoken and written forms, is to break it down into small units.

According to Sternberg and Sternberg (2012), the smallest sound unit is known as a *phone*, which is "simply a vocal sound. A given phone may or may not be part of a particular language." (p. 365). A *phoneme* is "the smallest unit of speech sound that can be used to distinguish one utterance in a given language from another." (p. 365). Long (2000) estimated that the English language counts around 40 basic phonemes, which are made up of *consonants* and *vowels*. He pointed out that consonant sounds are produced by "closing or restricting the shape of the vocal tract in some way." (p. 189). On the other hand, vowel sounds "are made with a relatively free flow of air and are formed by the shape of the tongue." (p. 189). *Phonemes* are joined together to make up words, and each language has its own set of rules of how *phonemes* are articulated and follow each other. *Phonemes* are studied within the field of *phonetics*, while *phones* are studied in the field of *phonology*.

At a higher structural level, *morpheme*s are recognised as being "the smallest meaningful units of language." (Galotti, 2012, p. 339). Morphemes are distinguished into two types. *Free morphemes*; for example, 'cat', 'write' and 'book', are units that can be used

alone in that they carry full meaning. *Bound morphemes*; for instance, '-s', '-ing', and 'dis-', are units that do not have to be used alone and need to be joined with a free morpheme to convey the bulk of meaning that a word carries; they include prefixes, suffixes and inflectional endings. The linguistic branch concerned with the study of morphemes and their combination is known as *morphology*. The entirety of morphemes in a particular language or in a given person's linguistic repertoire is called the l*exicon*. An adult speaker of English has a lexicon that approximately comprises 80,000 morphemes (Sternberg & Sternberg, 2012).

In the same vein, Harley (2001) indicated that words are not used one at time; they are connected together in strings such as phrases and sentences to express ideas. However, the use of language is not limited to understanding and producing sentences. Individuals tend to deal with large language input beyond the sentence level. This has to do with the discourse level, or combinations of sentences taking the form of paragraphs, texts, conversations, chapters of books and stories.

Finally, the study of language entails examining the relationships that tie the aforementioned components; these include syntactic, semantic and pragmatic relationships. First, syntax refers to "the arrangement of words within sentences or, more broadly, the structure of sentences—their parts and the way the parts are put together." (Galotti, 2012, p. 343). Thus, syntax is concerned with grammar or the grammatical rules that govern the construction of sentences within a given language. Second, semantics has recourse to the study of meaning in a language. Sternberg and Sternberg (2012) illustrated that "a semanticist would be concerned with how words and sentences express meaning." (p. 368). Moreover, major concerns of semanticists are words denotations (dictionary definitions or literal meanings) and words connotations (words' inexplicit meanings). Third, pragmatics focuses on "the intended meaning and functions of what is said, rather than its literal meaning, and depends on our shared knowledge and understanding of social encounters." (Long, 2000,

p. 194). Expressly, the pragmatic aspects of language components pertain to using them in ways that conform to social rules or conventions within a particular speech community.

1.3.2.2.8.2. Language Processing

Practically, processing language entails converting words into thoughts (recognition and comprehension); contrariwise, it involves converting thoughts into words (production and use) at a set of levels: sounds, words, sentences, text and discourse.

1.3.2.2.8.2.1. Language Recognition and Comprehension

Similar to other types of information, language needs to be converted from a raw input into comprehensible representations. That is to say, to comprehend spoken and written language input, an individual undergoes a number of processing stages; these involve perception, recognition and comprehension.

The initial stage involves the perception of auditory (spoken) and/or visual (visual) language input. On the one hand, speech perception entails a quick detection of the acoustic features of auditory stimuli. According to Sternberg and Sternberg (2012), a fluent speaker of a language is capable of perceiving around (50) phonemes per second. However, when faced with non-speech sounds, one can perceive less than one phone per second. Such a constraint spells out the fact that foreign languages are barely understood when heard. Speech is characterised by being continuous; that is, there are no pauses around sounds. Besides, phonemes in words sound differently from one speaker to another in that it depends on the context in which the words are used, pitch, and frequency. On the other hand, written input perception is related to how people read and consists primarily of eye-fixations, brief pauses one makes at strings of letters and words.

Crucial to understanding what we say or hear is the ability to recognise the words that build up a message. "Recognition involves identifying an item as familiar." (Harley, 2001, p. 152). Word recognition is a thoroughly investigated area is in cognitive psychology;

particularly the mental processes involved in such a process, the speed at which people can recognise words and the factors affecting this ability. According to Groome (1999), a study showed that people, on average, can identify target words in speech in around "275-370 milliseconds". Likewise, it was revealed that a reader can recognize written words as fast as "150 milliseconds" (p. 135). In parallel, there are a number of factors that impact the efficiency of word recognition. Word recognition depends on the frequency of occurrence in the language (highly frequent word are recognised faster compared to less frequent words), word-length, context (words are better recognised in context). Moreover, word recognition is influenced by semantic priming, an effect of context in which the preceding of a word or sentence might impact the recognition of a following word. The efficiency of word recognition may also be determined by access to the mental lexicon. This last refers to the store of knowledge held about words—form, meaning, pronunciation, grammatical roles, and so on. In this regard, there are two models of lexical access: the *direct access* model assumes that the lexicon comprises a detection device for every lexical unit; the *serial search* model supposes that lexical items in the store are examined one by one until the features of the target word are matched.

Eventually, comprehension is an ultimate stage in the process transforming language input into meaningful representations. According to Eyseneck and Keane (2000), comprehension, in contrast to other aspects of language processing that differ between listening and reading, involves higher-level processes that are often similar. Comprehension includes two levels of analysis of sentences: syntactic and semantic. First, syntactic processing, also referred to as *parsing*, has to do with assigning grammatical structure to word combinations as way of interpreting the message embodied in. On a similar note, listeners and readers first analyse and judge whether a sentence is syntactically permissible or not; besides, they tend to resolve the ambiguity that might surround a sentence. Syntactic parsing is often

influenced by the amount of grammatical knowledge and the context in which the words are encountered. Second, semantic parsing involves the analysis of the meaning(s) of sentences. Important to realize that not the intended meaning in a sentences may and may not be identical to its literal meaning. Consequently, semantic parsing is employed to interpret and judge the plausibility of the intended meaning(s).

1.3.2.2.8.2.2. Language Production

Language production is a fundamental aspect of language processing that mainly involves converting thoughts into words. One problematic issue that arises in studying language production is the difficulty of observing thoughts before they are expressed out. According to Groome et al (1999), one effective strategy to explore spoken production is analysing speech output for *slips of the tongue,* the different sorts of mistakes which people often make as they talk. On the basis thereof, psycholinguistics found errors quite revealing; they do not stem from random substitution, omissions or insertions. Errors are classified into four categories (p. 142):

● *Word substitutions*; for example, "boy" for "girl" and "black for "white".

● Word exchange such as "Fancy getting your model renosed" for "getting your nose remodeled."

● Sound exchange; for instance, "shinking ships" for "sinking ships".

● Morpheme exchange like "slicely thinned" for "thinly sliced."

To illustrate, Harley (2011, p. 375) explained that sentence production involves a sequence of stages of processing that take place separately. Initially, at the *message level stage*, an individual conceptualizes what to say; that is, s/he selects pertinent information to construct and intended utterance. Then, at *the formulation stage*, an individual is presumed to convert the conceptual representation into linguistic forms, select the appropriate vocabulary items stored in the mental lexicon (lexicalization), combining words to form sentences in

compliance with the syntactic rules that govern the language, set a phonetic and articulatory plan, turning words into sounds (phonological encoding). Finally, at the *articulation stage*, an individual is supposed to retrieve chunks of internal speech and articulate the intended utterance (motor-execution).

Furthermore, Eysenck and Keane (2000) discussed a number of processes involved in the production of written language. Similar to speech production, they argued that writing incorporates a series of systematic processes that involve the retrieval and organistion of information stored in LTM. Besides, they postulated that writing and thinking may be considered as two sides of the same coin. First, the *planning process* involves generating ideas and arranging them in a way that could satisfy the objective the writer intends to fulfill. Second, at the *sentence-generation process*, the writer chooses the suitable lexical units drawing on the mental lexicon and links them to construct grammatically and semantically convenient sentences. Third, th*e revision stage* entails evaluating what has been produced at a specific level (focus on individual words) or at a general level (focus on the coherence of the text). The writer often makes changes s/he finds necessary to successfully communicate the intended message.

1.3.2.2.8.3. Language Development

Alongside defining language as a mental faculty and the processes which it involves to comprehend and use verbal input, cognitive psychologists also concerned with describing the different stages involved in the acquisition of language. Glassman and Hadad (2009) gave a description of the phases that an individual undergoes while acquiring his/or her mother tongue from birth to adulthood. A six month baby starts by producing a wide range of meaningless sounds, a stage called *babbling*. At around one year of age, the first words begin to come out. At about one a half to two years, an infant can produce two-word utterances; for instance, utterances like 'that red' for 'that is red', or 'see mummy' for 'I see mummy'."

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(p. 202). These phases are recognised as *telegraphic speech*. At the age of two years, a normal child can utter around a dozen of two-word sentences. Henceforth, the development of language skills accelerates. By the age of three, the child begins to absorb the syntactic aspects of language (e.g. prepositions, forms of verbs). Besides, a typical three years child is estimated to know nearly 1000 words, and the size duplicates in the following year. By about four to five years, a child becomes capable of producing grammatically acceptable sentences albeit with less sophisticated structure than adults'. The rapid development in language acquisition suggested that languages are best acquired during childhood, or what was referred to as the *critical period hypothesis*. After this period, it was presumed that language becomes more difficult to acquire because it is an ability that declines with aging as long as the brain starts to lose its plasticity as a result of what is known as *fossilization*. Moreover, some scholars like Noam Chomsky speculated that individuals are equipped with a *language acquisition device*, an innate capacity to acquire the syntactic structures of a language. In regard to these assumptions, cognitive psychologists remain, however, reluctant to describe language capacity as being innate. First, a growing body of evidence postulates that learning plays a crucial role in language development. In addition, individuals manifest differences in abilities in acquiring languages, an issue that is not addressed in the notion of innateness.

1.3.2.2.8.4. Neuropsychological Views of Language

As indicated earlier, to achieve a deeper understanding of language processing, cognitive psychologists draw on findings in neuropsychology about the association between the brain architecture and language comprehension and production. Development in neuroimaging techniques allowed the localization of specific brain regions that are highly pertinent to language function. Galotti (2008, pp. 379-382) reported two brain regions as being responsible for language processing and/or deficits in coping with verbal tasks. First, *Broca's* area, named after the French physician Pierre Paul Broca, is a brain region located in

the left frontal lobe presumed to be responsible for the production of speech. Studies have demonstrated that damage in this area leads to *expressive aphasia*, a language disorder characterised by difficulties in producing coherent speech. Second, *Wernicke's* area, bearing the name of the German neurologist Carl Wernicke, is involved in processing speech and understanding verbal input. Typically, damage or even a small lesion in this area is highly likely to result in what is called *receptive aphasia*, a language disorder connected with a disability to comprehend the meaning of spoken words and sentences. As for written language, research has revealed that the regions of the brain activated when dealing with written input are separate from regions activated with speech. Correspondingly, written language was found to engage both hemispheres of the brain at the level of the motor cortex.

1.3.2.2.8.5. Second Language Acquisition/Learning

The process of acquiring /learning another language other than the mother tongue is another issue that has received a great deal of attention in language research. As a result, numerous theories have been developed; particularly Second Language Acquisition (SLA) theory, which address a number of aspects within this process. For example, the acquisition-learning distinction, the cognitive and psychological factors related to SLA success, the role of instruction, exposure to the TL, and the age of the acquirer/learner.

1.3.2.2.8.5.1. The Acquisition-Learning Distinction

The American linguistic Stephen Krashen has made significant contributions to the field of SLA. He argued that *acquisition* and *learning* are sharply different processes. On the one hand, he defined *acquisition* as

> a process similar, if not identical, to the way children develop
> ability in their first language. Language acquisition is a
> subconscious process; language acquirers are not usually aware
> of the fact that they are acquiring language, but are only aware
> of the fact that they are using the language for communication.
> The result of language acquisition, acquired competence, is also

> subconscious. We are generally not consciously aware of the rules of the languages we have acquired. Instead, we have a "feel" for correctness. Grammatical sentences "sound" right, or "feel" right, and errors feel wrong, even if we do not consciously know what rule was violated. (Krashen, 1982, p. 10).

This implies that *acquisition* entails the implicit absorption of different aspects of the language system without the engagement of consciousness. An adequate mastery over the acquired language is measured by the development of the "grammatical feel" that allows making distinction between syntactically acceptable and unacceptable forms of language. By way of contrast, Krashen (1982, p. 10) defined *learning* as a

> conscious knowledge of a second language, knowing the rules, being aware of them, and being able to talk about them. In non-technical terms, learning is "knowing about" a language, known to most people as "grammar", or "rules". Some synonyms include formal knowledge of a language, or explicit learning.

With that said, *learning* involves an explicit absorption of the language system in which consciousness is a prerequisite. Important to note, however, that acquisition is not limited to children as far as adults can attain a native-like competence. On the basis thereof, many references use the terms "acquisition" and "learning" interchangeably.

1.3.2.2.8.5.2. Psychological Considerations of Second Language Acquisition

Jordan et al. (2008) argued that, until the age of 12, individuals manifest remarkable abilities to learn a second or third language, particularly if they receive plentiful exposure to the TL. For the most part, it is believed that the same level of fluency is hardly attained in a second or third language as in the mother tongue. Harley (2001) discussed a number of reasons behind the difficulties encountered while learning the TL. Practically, some aspects of the language, especially grammar, are barely mastered outside the critical period. Moreover,

adults tend to have less time and motivation to learn another language. In addition, acquiring mastery over the L2 depends on the extent to which it differs from the L1. Differently put, "the more idiosyncratic a feature is in a particular language relative to other languages, the more difficult it will be to acquire." (p. 146). Finally, the itinerary of L2 acquisition follows a U-shaped curve: performance during the initial stages of the process is often satisfactory, and then it declines before an individual develops the language skills. Such a decline is attributed to the replacement of more complex internal representations to less complex ones. This is reflected in the tendency of learners to use shorter utterances instead of longer ones as a consequence of moving from rote-learning to developing awareness of grammatical rules.

1.3.3. Social Learning (Constructivism)

Constructivism is one of the most prevailing learning theories following cognitivism. According to Long (2000), contructivism is founded on the assumption that individuals construct knowledge and understanding of many aspects of the world through social interaction. Pritchard (2008) mentioned that "in social constructivism theory, emphasis is placed upon interaction between the learner and others." (p. 24). Within the same context, social constructivist views were advocated by the Russian psychologist Lev Vygotsky at the start of the 20th century. Vygotsky believed that the development of children's cognitive abilities undergoes the same stages proposed by Piaget; that is, children's learning initially depends on direct experiences and interaction with the surrounding environment then shifts to more abstract and sophisticated thinking. Vygotsky added that children acquire and construct knowledge as they internalise experiences through observing their parents. More importantly, language is prioritized as the basic means of cognitive development which is embodied within their culture. Therefore, children from different social backgrounds show significant differences in thinking and values.

1.3.3.1. The Zone of Proximal Development

A widely accepted notion based on Vygostky's reflections on how children's thinking develops is known as the *proximal development zone*. Garton (1995) reported that

> the existence of the zone of proximal development, which is defined as the distance between the child's actual developmental level (as measured by conventional IQ tests for example), and her potential developmental level, as seen when a child is solving problems in interaction with "an adult or more capable peer. (p. 95).

Vygotsky held that children start to acquire understanding through interaction with more knowledgeable peers who provide them with support that allows them to function within a learning space quite beyond their own cognitive capacities. In doing so, children are supposed to mimic and internalise the actions of the collaborative peers and attain higher stages of cognitive progress.

1.3.3.2. Scaffolding

Similar to the preceding idea of the proximal development zone, *scaffolding* is recognised as being another way of promoting cognitive development through interaction with more adept individuals. Long (2000) explained the notion of scaffolding stating that "the adult supplies initial support to enable children to construct their understanding, and that this support is then withdrawn when they have independent abilities. (p. 36). On that basis, scaffolding implies creating learning experiences in which teaching has two main purposes. Initially, the intervention and help of a teacher or a parent is necessary at the early stages of learning. Afterwards, as the learner makes noticeable progress and becomes actually capable of handling the task individually, the teacher or the parent is supposed to minimize the support or help. It is worth noting that in scaffolding the learner should be actively engaged in the learning activities that are, in turn, supposed to attract maximum interest of the learner.

Conclusion

Learning is by far one of, if not, the most sophisticated processes to understand. Attempts to find out about how people develop knowledge and skills are deeply rooted in history. Consequently, a wide diversity of views has been promoted; each view provides elaboration and offers insights about how learning takes place. Behaviourists regard learning as a relationship between stimulus and response but neglect the cognitive factors that contribute in shaping one's behaviour. Cognitivists believe that learning involves developing ways of constructing and applying knowledge in interaction with the environment; they primarily focus on the role of diverse mental faculties in shaping knowledge. Additionally, they rely on experimental evidence in addressing issues under scrutiny. Finally, social constructivists maintain that learning is the result of interaction with other peers within a particular surrounding. That is, cognitive development entails internalising the actions perceived in other peers. However, no theory is believed to provide full explanations as far as learning remains to be an enigmatic phenomenon.

ChapterTwo

The Working Memory and its Capacity

Introduction

Introduction

Generally speaking, memory refers to one's ability to remember information for particular purposes in various situations for a certain period of time. The working memory (WM) is a limited-capacity cognitive construct that plays a vital role in numerous mental processes such as reasoning, planning, problem solving, decision-making, attention, perception, intelligence and language. In the last 30 years, an abundant amount of research endeavours carried out in cognitive psychology and neuroscience has significantly contributed to address key issues about the WM, its conception, its internal components, primary functions, and how it interacts with other mental faculties. As a result, several models were conceptualized, each of which stems from theoretical insights and experimental evidence regarding its nature and mechanisms. In fact, there is no agreement about one model, but there are widely accepted beliefs about the cognitive operations and mechanisms of the WM and its capacity; for instance, multiple components of the WM intervene in encoding, storing, maintaining, processing and manipulating, rehearsing and retrieving information in interaction with other models of memory primarily including the STM and LTM. It also plays an substantial role in focusing attention, resisting distractions and comprehension of information in various situations. Above all, measuring the working memory capacity might have important implications for understanding why individuals differ in cognitive skills and abilities and allow the development of methods enhancing its functioning to cope with diverse cognitive tasks.

2.1. Definition of the Human Memory

Memory is a cognitive construct that plays a crucial role in almost all human activities. Essentially, it is one's ability to store information for potential retrieval at certain future occasions. Wingfield and Byrnes (1981) defined memory as the "capacities human beings have to retain information, to recall it when needed, and to recognize its familiarity when they

later see or hear it again." (p. 4). Studies on memory seek to explain how such capacities are exploited by individuals to cope with everyday activities, how it can be measured and improved. The subject of memory has long been thoroughly enquired in a multiplicity of disciplines including psychology, philosophy, neurology, biology, education, and so on. One way to consider the importance of memory is to figure out its inexistence in one's life. Baddeley (1999) acknowledged the contribution of memory to humans' survival stating that:

> Perhaps the best way of appreciating the importance of memory
> is to consider what it would be like to live without it, or rather
> without them, as memory is not a single organ like the heart or
> liver, but an alliance of systems that work together, allowing us
> to learn from the past and predict the future. (p. 1)

2.1.1. Historical Trends of Memory Research

Attempts to understand the nature of human memory extend back to ancient Greek philosophers. Numerous pertinent issues had been raised and, consequently, the concept of memory has undergone considerable refinements starting from ancient Greeks to the mid-twentieth century. According to Radvansky (2017), the eminent Greek philosopher Plato viewed memory as a bridge that links the perceptual world and a rational world of idealized abstractions. Plato's thoughts were later reconsidered by other philosophers like René Descartes, Immanuel Kant and his distinguished pupil Aristotle. This last held the idea that memories are mainly made up of associations created between various stimuli and experience. In the medieval times, Charles Darwin came up with some influential ideas explaining that memory has developed through the process of evolution to apprehend major characteristics of the surrounding environment and to cope with specific tasks. Such a view is based on the thoughts that our memories depend on the genetic make-up of our brains. However, our genes do not control our memory mechanisms in a direct way, but still there are other factors such as experience. By the 1850s, memory became a hotly debated issue in modern psychology.

The German Psychologist Hermann Ebbinghaus (1850-1908) made significant contributions to the scientific study of memory through using a form of a test known as the *non-sense syllable approach*. The premise was to memorize lists of meaningless words and associating them with meaningful ones. The approach yielded valuable insights about memory mechanisms such as the learning curve, the forgetting curve, over-learning and savings, which had implications to a subsequent division of memory into: sensory memory, Short-Term Memory (STM) and Long-Term Memory (LTM). Another contribution was made by the famous British psychologist Frederick Barlett (1886-1969). Barlett claimed that memory heavily depends on an individual's prior knowledge. In other words, he argued that any memory store is fragmentary and incomplete, so that whenever people remember something, they reconstruct the already stored pieces of information drawing on prior knowledge about certain circumstances to form what he called "schemas". Subsequently, one more particular contribution to the understanding of memory was attributed to the American psychologist William James (1842-1910). James distinguished two types of memory: the *primary memory* and the *secondary memory*. The former holds information temporarily, while the latter holds information for long periods of time. Such a distinction is pertinent to the currently used terms for memory types: STM and LTM.

2.2. The Major Processes of Memory

A key issue to the understanding of human memory is to identify, separately, the processes involved in memorizing different sorts of information: visual, auditory (acoustic), semantic, kinesthetic, tactile, haptic and so on. Memory is regarded as a process that comprises distinct, but inextricably connected stages. Firstly, it starts with encoding, or the input stage, where newly encountered information is learned or encoded over perception and attention. Secondly, there comes rehearsal, which involves silently or loudly reciting an encoded item to maintain it active. Thirdly, a storage stage is undergone to maintain a piece of

information in preparation to cope with in future situations. Fourthly, there is the retrieval stage, or the output stage, where already consolidated information is retrieved from storage. Figure (2.1) depicts the major stages in memory process.

| Encoding | ⟶ | Storage | ⟶ | Retrieval |

Figure 2.1. The Major Processes of Memory (Foster, 2009, p. 25)

2.2.1. Encoding

Encoding is an essential concept in memory research. It has to do with acquiring or taking in various sorts of information received from the environment through attention and perception. Davachi (2007, p. 135) defined encoding as "the processes (cognitive, systems, cellular and molecular) by which a stimulus or event leads to alteration of the brain." He added that "it occurs during attention to and/or perception of stimulus (internal or external) and may even persist for some time after attention has been drawn away from the stimulus event." Furthermore, Dehn (2008, p.56) suggested that encoding can be divided into two types: *basic* and *complex*. On the one hand, *basic encoding* means "the conversion of perceptual input into a code suitable for short term or long term storage."On the other hand, *complex encoding* is defined as "the process of associating meaningful information with related schemas in long term storage." Additionally, the existence of encoding can only be assumed by successful retrieval and recovery of stimuli taking place at a later time. According to Sternberg (2009), types of encoding depend on the type of information come across. For instance, visual encoding embraces images and sounds, acoustic encoding focuses on sounds, whereas semantic encoding deals with letters and words.

2.2.2. Rehearsal

According to Sternberg (2005, 2009), Rehearsal is recognized as being a technique inherent to memory; it entails the repeated recitation of an information piece in order to keep it active. Research on memory has distinguished two common types of rehearsal: *overt* rehearsal and *covert* rehearsal. The former tends to be aloud and noticeable by anyone watching, while the latter is usually silent and hidden. Besides, the effects of rehearsal are coined *practice effects*.

2.2.3. Storage

Storage is another memory-related stage that refers to the ability to store an already encoded piece of information and retain it over a particular period of time. Sternberg and Sternberg (2012, pp. 231-233) differentiated two widely-accepted types of storage: the short-term and the long-term sorts of storage. The short-term storage, on the one hand, indicates holding a piece of information for a temporary use, and it is more subjected to forgetting. It is predominantly acoustic in nature; that is, sounds could be memorized more easily compared to semantic and visual input (visual input is assumed to last for no more than 1.5 seconds). Long-term storage, on the other hand, has to do with keeping information to be retained for long periods of time. Particularly, most information stored for a long-term take a semantic form. Put differently, among the several types of encoded information (acoustic, visual, tactile), words and meanings remain more available for subsequent retrieval. Finally, initially encountered information is often likely to be transferred from the short-term to the long term store going through a process known as *consolidation*.

2.2.4. Retrieval

Retrieval refers to the process of recalling or accessing already stored information. Roediger (2003, In Byrne, 2003) emphasized that retrieval is the essential process in the act of remembering. To point out, acquiring different pieces of information constantly does not

ensure the ability to store it out whenever needed. This might be explained by the absence of a memory trace that allows reaching it. This led to the distinction made between '*available*'and '*accessible*' items in a memory store. Sternberg (2009) clarified that "availability is the presence of information stored in long-term memory. Accessibility is the degree to which we can gain access to the available information." (p. 231). Memory researchers believe that remembering depends on the accessibility rather than the availability of information. Thus, in order to make a successful retrieval, an individual needs some reminders widely known as 'cues'. Esgate and Groome (2005) defined such means as "items of information that jog our memory for a specific item, by somehow activating the relevant memory trace." (p. 24). Retrieval may also take two forms: recall and recognition, particularly in memory performance measurement. Equally, they differentiated between the two forms asserting that

> In recognition the test material is reinstated at the retrieval stage and subjects must decide whether or not it is familiar from the test session, whereas in a spontaneous recall test subjects are required to generate test items purely from their own memory (p. 76).

2.3. Mapping Human Memories (Taxonomy of Memorial Models)

One more critical issue considered in enquiring memory is to devise its structure. Therefore, the sub-taxonomy of memory remains to be a subject of extensive debate. Researchers, by way of categorizing the core memory processes, have suggested various models, each with a slightly differing architecture. According to Baddeley (1999), types of memories are distinguished on the basis of the amount of information that each type can hold (capacity), the amount of time along which a piece of memory can be expected to last (duration), and how a piece of information may be lost from the system (forgetting). As a result, advancement in cognitive psychology, educational psychology, neuropsychology, and other related disciplines has led to the propagation of several theories and models.

2.3.1. The Atkinson and Shiffrin *Modal* Model 1969

Foster (2009) indicated that during the 1960s, attempts to conceptualise a working model of human memory, based upon information-processing models, had been taking place. They were motivated by the drastic advancements in information technology after the Second World War to understand how information is stored during a computer processing in what was called the *computer metaphor* regarding the resemblance between the way humans process information and that of a computer. Consequently, memory researchers started to conceive memory as a process comprising multiple subdivisions rather than a single entity. The first formal model was proposed by Attkinson and Shiffrin in 1968, at Stanford University, also known as the multi-store or *Modal* model. It offered a convenient and widely accepted framework for memory. They divided memory into three sorts of storage: the sensory store (also termed *immediate memory*), the short-term store (STS), and the long-term store (LTS).

Figure 2.2. the Modal Model of Memory Proposed by Atkinson and Shiffrin 1968

(Baddeley, 2007, p. 3)
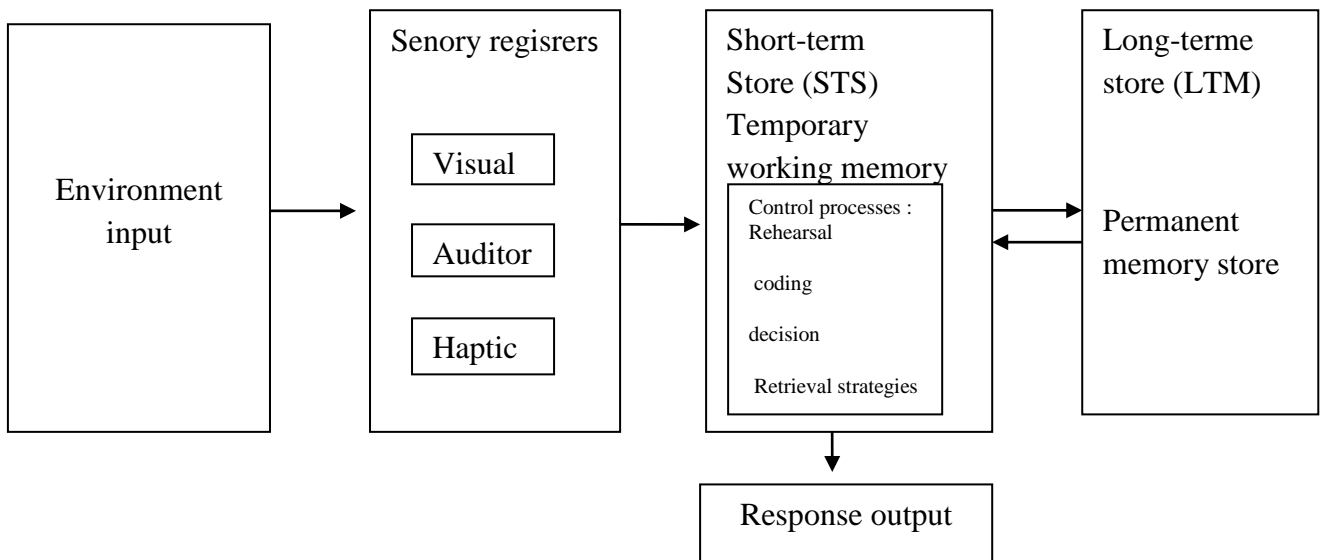
They speculated, according to Baddeley (2006), that when an environmental stimulus is detected, the information comes in to be processed by certain temporary sensory memory systems, and then transferred into a limited-capacity Short-Term Store (STS) which was believed to function as WM or a system for manipulating information to perform multiple cognitive tasks and exchanging information with LTM. Afterwards, information can either be maintained through rehearsal (sub-vocal repetition) to be fed into the Long-Term Store (LTS) or rather fades away; besides, the learning process is assumed to depend on the period information is held in the STS. The LTS, on the other hand, is referred to as a large-capacity store where information could be indefinitely retained for later retrieval. The modal model was criticised on a number of grounds. Dehn (2008) argued that it was "an oversimplification of memory and […] place too much emphasis on structure while ignoring the processes." (p. 13). Accordingly, there was little evidence to confirm that merely holding information in the STS would make learning easy. Put differently, the probability of transferring information into LTS leading to a better learning was unsuccessfully tested. Richardson et al. (1996) addressed another issue claiming that "Atkinson and Shiffrin did not appear to attach special importance to the working memory component of the system, and did not consider its possible contribution to tasks beyond the domain of learning and memory." (p. 5). Nevertheless, the model remains to be accepted as a groundbreaking framework in that it influenced subsequent memory conceptualisation attempts.

2.3.1.1. Sensory Memory

The sensory memory, sometimes referred to as *perceptual storage*, is widely understood as a store of information extracted from environmental stimuli. Baddeley (1999) affirms that sensory memory systems are intimately linked, if not part of, our perception of the outside world. Consistent with this, sensory memory systems deal with persisting represented information that an individual may confront; they have to do with visual,

auditory, olfactory (pertaining to smell), gustatory (pertaining to taste), tactile (pertaining to touch) types of incoming input for a short time. Cowan (2008) stated that "sensory memory refers to the short-lived memory for sensory details of events; […] it allows us to recognize a familiar voice over the telephone or to recognize the taste of a favorite food." (p.23). Wingfield and Byrnes (1981) viewed that sensory memory differs from other types of stores in terms of three characteristics: content, capacity and duration. First, the content of the store consists of the sensory details or physical features of items. Second, it has a relatively large capacity in that one may hold a large amount of perceptual information at a single glance. Third, it has a very brief duration measured by fractions of seconds; additionally, information held is highly likely to fade away if it were not attended to or processed. Pashler (2003) affirmed that "sensory memory systems can potentially retain a large amount of detailed sensory information about an input for an extremely brief period. (p. 49). In the same context, the bulk of memory research to date has concentrated on two types of sensory memory: the *iconic* memory and *echoic* memory. The iconic memory is a visual sensory register that holds information for very short periods (100 to 400 milliseconds), depending on the physical properties of the perceived object. The echoic memory, on the other hand, is an auditory store related to sounds and acoustic input that could retain information for one to two seconds. Finally, it is agreed that echoic memory is larger in capacity than iconic memory in that sounds are retained for a longer time compared to images.

2.3.1.2. The Short-Term Memory

The term Short-Term Memory (STM) was used as replacement for the Short-Term Store (STS) in the memory *modal* model proposed by Atkinson and Shiffrin in the 1960s. Groome (2005) defined it as "the memories which we are holding in conscious awareness, and which are currently receiving our attention." (p. 60). The STM is also referred to as *active* memory or *primary* memory. According to Thorn and Page (2009), STM interacts with the

sensory memory and the LTM in that information passes through a sensory register to be re-coded in STM on a temporary basis. If the items in STM are adequately rehearsed or maintained active, they would be highly likely to be transferred to LTM, otherwise they will be lost. In parallel, items retrieved from LTM are copied back into STM to be produced as output. Yen (2008) depicted two major characteristics of STM. First, it is limited in duration where information is held for a short amount of time (15-30 seconds) before it is copied into LTM or it decays. Second, STM has a limited storage capacity conventionally estimated by seven items, plus or minus two (7± 2 items). This was first assumed by Princeton University Psychology professor George A. Miller in 1956 under the label *The Magic Number Seven, Plus or Minus Two.*

2.3.1.3. The Long-Term Memory

On the contrary to sensory memory and STM, which are considered as two stores of a limited capacity and duration (determined by fractions of a second, seconds or a minute), the Long-Term Memory (LTM) is rather a large capacity store of an indefinite duration. In a broader perspective, LTM is able to retain information over extended periods of time that may last minutes, hours, or a life span. It is also termed *passive* or *secondary* memory. Homa (2008) stated that "long-term memory (LTM) refers to people's vast storehouse of retrievable other than perceptual and short-term memory."(p. 620). It usually remains dormant until activated by particular stimulus and is divided into a couple of components. This implies that LTM consistently interacts with sensory and short-term memories. Foster (2009) explained that "information could only reach long-term memory by first passing the short term store, and rehearsing information in the short-store would both retain it in this store; and increase its chance of being transferred to the long term store."(p. 31). Founded on the idea that rehearsal is not sufficient to ensure long-term storage, Gluck, Mercado and Myers (2008) assumed that information retention and retrieval from LTM occur by means of two processes: the depth of

processing effect (the level of activity devoted to new information) and passive rehearsal. So, the LTM is sometimes referred to as the '*black box'* where a vast amount of information could be stored for a period that is difficult to quantify, or simply a permanent store with an unlimited capacity. Galotti (2008) illustrated a number of formsthat informative knowledge in LTM may take. She stated that,

> It would have to include your memory of all the word meanings you know (probably between 50,000 and 100,000), all the arithmetic facts, and all the historical, geographic, political and other kinds of information you have learned. You also probably stored in LTM at one time or another names and faces of all sorts of people: family members, significant teachers, neighbors, friends, enemies and others. You also surely have stored various pieces of other information about each of them: physical attributes, birthdays, favorite color or musical group, and so on. All your information about various ways of doing familiar things—getting a manuscript from the register's office; checking out a book from the library; asking for, accepting, or tuning down a date; finding a phone number; addressing a letter must also be in LTM (p. 184)

In a narrower perspective, the broad diversity of informative knowledge thought to be stored in the LTM has led scholars in psychology and cognitive psychology to fractionate it into different types, each of which is specialized in certain types of information. Conventionally, The LTM is divided, at a top level, into an explicit memory (conscious) and implicit (unconscious) memory. On the one hand, the implicit memory comprises the declarative memory (facts, concepts and events) and is divided into episodic memory (events and experiences) and semantic memory (words, facts and concepts). On the other hand, the implicit memory incorporates the procedural memory (skills and habits).

Figure 2.3. The Division of LTM Systems (Radvansky, 2017, p. 14)

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                    ┌──────────────┐
                    │  Long-Term   │
                    │    Memory    │
                    └──────┬───────┘
             ┌─────────────┴─────────────┐
    ┌────────┴─────────┐         ┌────────┴─────────┐
    │   Declarative    │         │  Non-Declarative │
    │ Memory (Explicit │         │ Memory (Implicit │
    │     Memory)      │         │     Memory)      │
    └────────┬─────────┘         └────────┬─────────┘
      ┌──────┴──────┐                     │
┌─────┴──────┐ ┌────┴──────┐       ┌──────┴──────┐
│  Episodic  │ │ Semantic  │       │ Procedural  │
│   Memory   │ │  Memory   │       │   Memory    │
└────────────┘ └───────────┘       └─────────────┘
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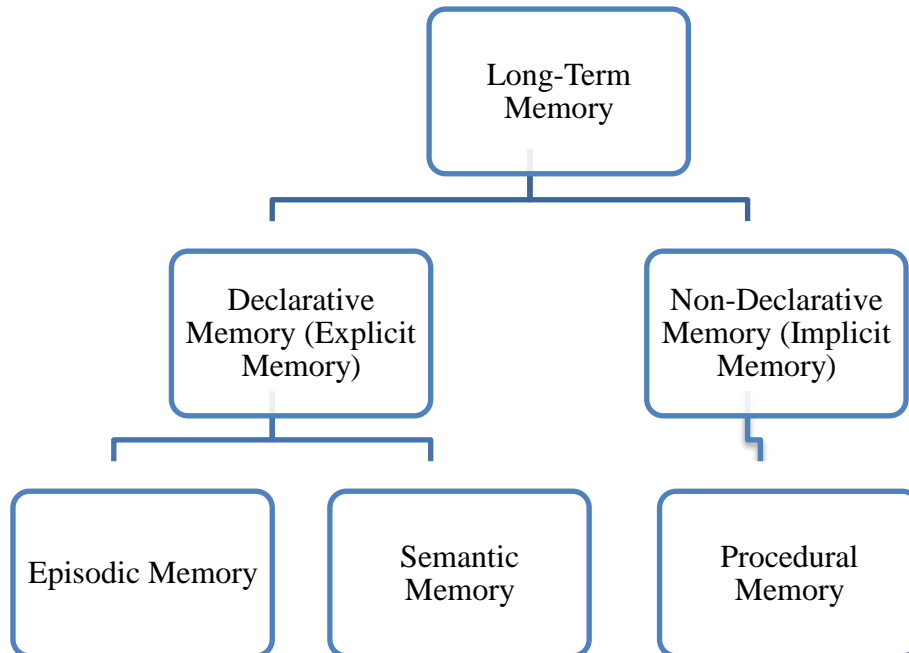
2.3.1.3.1. The Explicit Memory (the Declarative Memory)

According to Baddeley (1999), the explicit (declarative) memory was considered as part of the LTM by the Canadian experimental psychologist Endel Tulving in 1972. Such a type of memory stores "know what information"; for example, knowledge of facts, events and concepts that an individual is conscious of. It is subdivided into two types: the episodic memory and the semantic memory.

2.3.1.3.1.1. The Episodic Memory

As the name implies, the episodic memory has to do with someone's knowledge about specific events, experiences or incidents that have happened in a particular place at a particular time. For instance, what happened on your last birthday? Or, what did you have for breakfast this morning? Additionally, Baddeley, Kopelman and Wilson (2002) argued that a deficit in the episodic memory is postulated as the major hallmark of Alzheimer's disease.

2.3.1.3.1.2. The Semantic Memory

According to Foster (2009), the semantic memory refers to a stock of general knowledge about the world. This embraces knowledge of facts and concepts; for example, what is the capital city of Italy? Who was the first US. President? At what temperature does ice melt?

2.3.1.3.2. The Implicit Memory (the Procedural Memory)

Homa (2008) defined the implicit memory as "people's knowledge of sequences, events that occur in temporal order, such as riding a bike, typing on a keyboard, or driving a stick-shift." (p. 621). Thereby, this type of memory involves a stored knowledge of the procedures how to do things. Eyseneck and Keane (2000) asserted that implicit memory shows up when performance on a particular task is delivered in the absence of conscious recollection.

2.3.2. Levels-of-Processing (LOP) Hypothesis

To add a refinement to the typical memory model proposed by Atkinson and Shiffrin in 1968, and after a number of rational criticisms, Craick and Lockart (1972) suggested a theoretical framework that came to be known as *the levels of processinghypothesis*. They argued that memory should not be analysed in terms of the number of separate stores it involves, but rather on the depth of information processing or encoding as key to long-term storage. In other words, the durability of memory traces depends on the level of processing (LOP) of information attained instead of the length of time material is held in STS. Craick (1973) defined the depth as "the meaningfulness extracted from the stimulus rather than in terms of the number of analyses performed upon it." (p. 48). Though it would remain open to criticism, Baddeley (2006), commented on this framework, as far as it is applicable to learning, indicating that " there is no doubt that the concept of processing level gives a simple

account of a very robust phenomenon, which is, of great relevance to educational practice." (p. 4).

2.3.3. The Working Memory

2.3.3.1. Emergence of the Concept

The history of the Working Memory (WM) model stretches back to the early days of modern psychology. It is a synergy of proliferating theories and assumptions about the mechanisms of human memory (storing, encoding, rehearsing, contemplating, brining ideas to mind and forgetting). To date, the construct is still undgoing refinement as long as contributions from many fields investigating cognitive processes continually reveal its interference in a myriad of complex cognitive tasks; notably, in planning, reasoning, consciousness, attention, perception, problem-solving, decision-making, language learning and comprehension. The original model of WM was proposed in 1974 by Alan Baddeley and Graham Hitch at the Department of Experimental Psychology, University of Sussex, as fruit of a research work conducted to explore the relationship between STM and LTM. It was a further elaboration of the concept of STM—a limited-capacity temporary memory—typified in the modal model proposed by Attkinson and Shiffrin in 1968 based on empirical evidence gathered from experiments conducted with both healthy and brain-damaged individuals. Baddeley (1996) speculated that the concept of WM differs from that of STM in two aspects. First, it is supposed to comprise a number of subsystems, rather than a unitary entity. Second, there is sharper focus on its functioning in accomplishing other cognitive tasks; for instance, learning, reasoning and comprehension. Accordingly, the WM is added to the rest of stores (sensory, STM and LTM) as active system that holds and manipulates information coming from both STM and LTM.

The WM has become a central theoretical construct in a diversity of interlinked disciplines; namely, cognitive psychology, cognitive neuroscience and education. Baddeley

(1996) asserted that "within human experimental psychology, [...] the term working memory is taken to apply to a limited capacity system that is capable of storing and manipulating information and that is assumed to be an integral part of the human memory system." (p. 13486). Thus, WM may be described as a mechanism that underlies the maintenance of task-relevant information while performing a cognitive task. Shah and Miyake (1999) acknowledged that

> Working Memory plays an essential role in complex cognition. Everyday cognitive tasks—such as reading a newspaper article, calculating the appropriate amount to tip in a restaurant, mentally rearranging furniture in one's living room to create space for a new sofa, and comparing and contrasting various attributes of different apartments to decide which to rent—often involve multiple steps with intermediate results that need to be kept in mind temporarily to accomplish the task at hand successfully."(p. 1).

Similarly, Alloway (2006) pointed out that the WM "functions as a mental workspace that can be flexibly used to support everyday cognitive activities that require both processing and storage such as mental arithmetic." (p. 134). Another definition by Alloway and Alloway (2013) implied that WM is "a construct developed by cognitive psychologists to characterize and help further investigate how human beings maintain access to goal-relevant information in the face of concurrent processing and/or distraction." (p. 21). Equally, Conway (2005) believed that

> We need working memory in languagecomprehension, to retain earlier parts of a spoken message untilthey can be integrated with the later parts; in arithmetic, to retain partial results until the rest of the answer can be calculated; in reasoning, to retain the premises while working with them; and in most other typesof cognitive tasks. Moreover, we need working memory

> not only to holdnew information that has been given to us, but
> also to integrate it witholld information.. (p. 2)

Notwithstanding, the concept of WM itself has been widely adopted and, in consequence, several theories and models have emerged. For example, the Baddeley and Hitch Multi-Component model, Cowan's Embedded Processes Model, the Controlled Attention Framework, the ACT-R model, the Executive-Process/Interactive Control (EPIC) model, Soar Architecture, Long-Term Working Memory (LT-WM) Framework, Interactive Cognitive Subsystems (ICS) Model, Controlled and Automatic Processing (CAP2) Architecture and the Biologically Based Computational Model. The present study primarily focuses on Baddeley and Hitch Multi-component model as it is considered as the most prevailing one and a guiding framework that provided rational and well-established explanations about WM functioning in a broad diversity of references.

2.3.3.2. The Baddeley and Hitch Multi-Component Model

The influential model of the WM proposed by Baddeley and Hitch (1974) is a tripartite system that consists of three specialized operational components functioning in harmony: a supervisory system called the central executive aided by two subsidiary or 'slave' sub-systems known as the phonological loop (an acoustic store) and the visuospatial sketchpad (a spatial information store). The central executive is an attentional controller that orchestrates the activities of the phonological loop, which maintains and manipulates speech-based information, and the visuo-spatial sketchpad, which functions similarly with visual images. Baddeley (1999) illustrated that the three interrelated components of WM "allow humans to comprehend and mentally represent their immediate environment, to retain information about their immediate past experiences, to support the acquisition of new knowledge, to solve problems, and to formulate, relate, and act on current goals. (p. 29).

Figure 2.4. The Original Baddeley and Hitch (1974) Working Memory Model (Baddeley, 2012, p. 8)
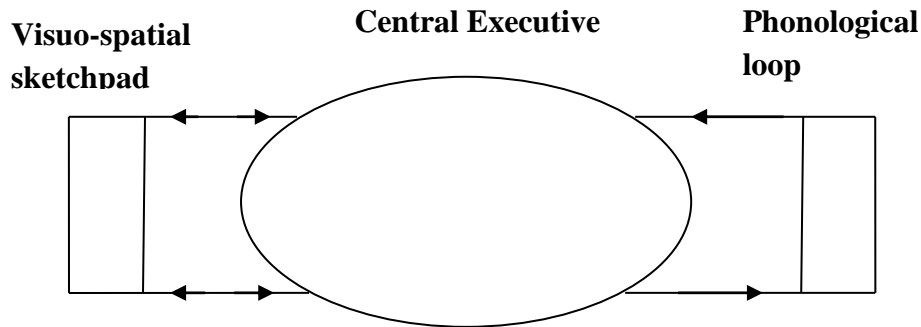
2.3.3.2.1. The Phonological Loop (Articulatory Loop/ The Inner Voice)

The phonological loop, originally termed the articulatory loop, is one of the slave systems in the Baddeley and Hitch framework. It represents a limited-capacity store of principally speech-based information as well as a rehearsal mechanism. Baddeley (2006) divided the loop into two subcomponents. First, a temporary storage system in which acoustic or phonological input can be held as a memory trace that fades away within a matter of 2-3 seconds if not refreshed by rehearsal. Second, a rehearsal system that involves some sort of sub-vocal articulation, hence the term "articulatory loop", where inner speech is used to revive the memory trace that can be retained indefinitely by means of continuous rehearsal. Dehn (2008) considered that the phonological loop is analogous to an audio tape recorder loop of a particular length. Words or other auditory units are recorded in the same order they are perceived, and they quickly decay or be recoded over by new auditory units unless rehearsal re-records them onto the tape. Alongside dealing with orally presented information, another operation carried out by the phonological loop is to convert visually presented material into a phonological code via subvocal naming. The phonological loop is thought to play an important role in language comprehension and development. Baddeley (1996)

confirmed that " the phonological loop might be necessary for new phonological learning, something of crucial importance for a child acquiring language but of much less significance for an adult, unless they are trying to learn a new language. "(p. 13470). He added that the capacity to hear and repeat back an unfamiliar word, which depends on the system's functioning, is a reliable predictor of the acquisition of new vocabulary in both children and adults acquiring their first and second language.

2.3.3.2.2. The Visuo-spatial Sketchpad

The visuo-spatial sketchpad, sometimes referred to as the *inner eye*, is another slave system, parallel to the phonological loop, that, as Baddeley (2006) asserted, "plays an important role in the acquisition of our visual and spatial knowledge of the world: what colour is a banana? How does a bicycle work? […] How can I find my way around my hometown?" (p. 13). According to Baddeley (1999), the concept of the visuo-spatial sketchpad was triggered by an interest scrutinizing the topic of visual imagery for it plays a central role in learning verbal material. Visual imagery mnemonic strategies were believed to facilitate remembering words, and words that are imageable are easier to memorise compared to those which are not. Besides, there was a debate among researchers as to whether images are stored in some way directly in the brain or created from abstract representation. After a number of experiments conducted to make a link between visual imagery with the WM, Baddeley (2006) concluded that the visuospatial sketchpad subcomponent of WM is responsible for the temporary storage of visual and spatial information, such as memory for things and their locations in space. Likewise, it contributes to generating and handling mental images. Baddeley (1986) divided the sketchpad into a passive short-term store and active rehearsal mechanism. Visually presented material maintained in the temporary store seems to be held for a matter of seconds unless rehearsal takes place. The speed of decay depends on the complexity and duration of the visual stimuli. Moreover, a visual memory trace is revived by

means of eye-movement, manipulation of the image (features like size and shape), or using some sort of visual mnemonics. Dehn (2008) reported that the visuospatial sketchpad has underlying implications to reading as it "visually encodes printed letters and words while maintaining a visuospatial frame of reference that allows the reader to backtrack and keep his or her place in the text." (p. 19).

2.3.3.2.3. The Central Executive

The Central Executive (CE) is regarded as the most important component of WM. Baddeley (2003) pointed out that it is the most complex and the least understood component regarding the multiplicity of cognitive processes that it performs. In general, the CE is an attentional supervisory system in an overall charge of controlling and regulating of the WM mechanisms. It also directs the functioning of the two sub-systems (the phonological loop and the visuospatial sketchpad). Baddeley (1996) characterized the CE as "the capacity to focus attention, to switch attention from one focus to another, and to use working memory to activate aspects of long-term memory." (p. 13471). Similarly, Baddeley and Logie (1999) postulated that the CE carries out such various executive functions as "coordinating the two slave systems, focusing and switching attention, and activating representations within long-term memory, but it is not involved in temporary storage." (p. 28). Dehn (2008) summerised the core functions of the CE as follows:

> (a) selective attention, which is the ability to focus on relevant
> information while inhibiting the disruptive effects of irrelevant
> information; (b) switching, which is the capacity to coordinate
> multiple concurrent cognitive activities, such as timesharing
> during dual tasks; (c) selecting and executing plans and flexible
> strategies; (d) the capacity to allocate resources to other parts of
> the working memory system; (e) the capacity to retrieve, hold
> and manipulate temporarily activated information from long-
> term memory. (p. 23).

Moreover, Baddeley (1996) argued that there was a consensus among theorists that the individual differences in the working memory capacity may be attributed to the CE functioning and which are typically related to performance on tasks such as comprehension, reasoning and general intelligence tests.

2.3.3.2.4. Introducing the Episodic Buffer

The multi-component model of WM, proposed by Baddeley and Hitch in 1974, has undergone further refinement to increase its theoretical depth. As a result, in 2000, Baddeley modified the original tripartite model and introduced a fourth component termed the *episodic buffer*. The revised model is assumed to extend the applicability of the model and provide a better basis for scrutinizing the more complex aspects of executive control in WM. Baddeley (2000)referred to it as "a limited-capacity system that provides temporary storage of information held in a multimodal code, which is capable of binding information from the subsidiary systems, from long-term memory, into a unitary episodic representation." (p. 1). According to baddeley (2007), the episodic buffer is accessed by the central executive via conscious awareness. Besides, it serves as an interface between the slave systems and LTM in that it binds information from a number of sources to be integrated into a limited number of coherent episodes or chunks. It acts as a buffer in a sense that it temporarily maintains information in multi-dimensional codes: visual, verbal, perceptual, and reactivated representations from episodic and semantic LTM. In doing so, it plays a fundamental role in learning and retrieval. For example, the episodic buffer is needed to string the sounds and words together to build a coherent sentence.

Figure 2.5. The Model Following the Introduction of a Fourth Component, The Episodic Buffer (Baddeley, 2000, p. 2)
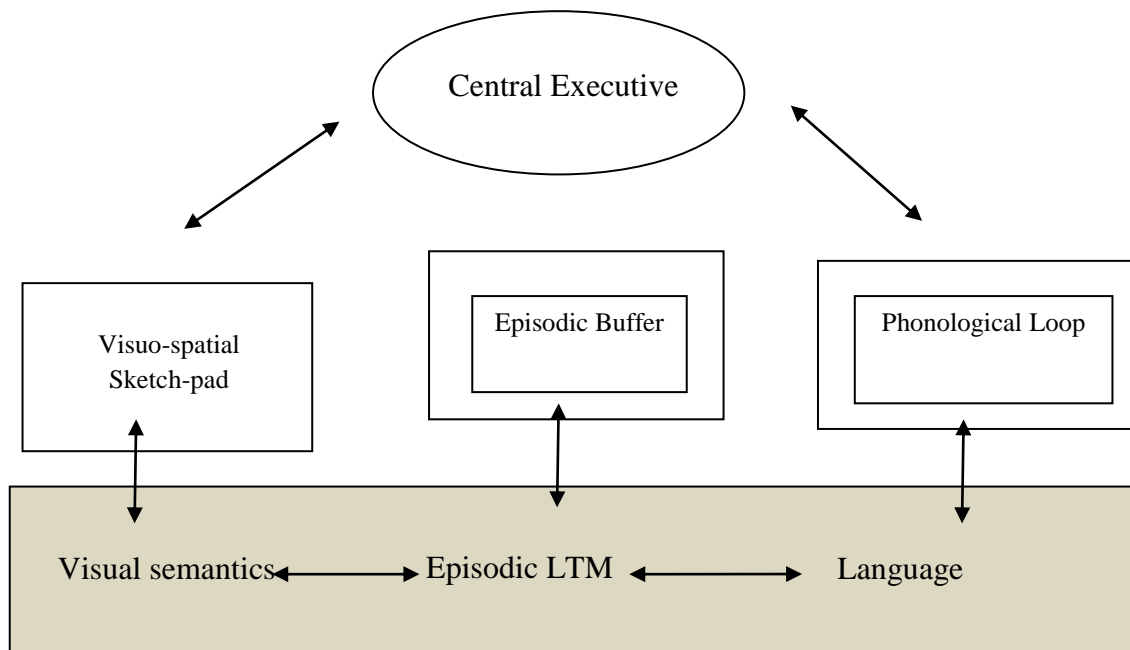
2.4. Measurement of the Working Memory Capacity

The concept WM is in essence a form of memory, but it remains quite difficult to define, for it is a memory at work rather than a store; it also combines a number of interrelated processes that carry out several cognitive functions. Moreover, a central characteristic of the WM is that it has a limited capacity which affects cognitive performance and differs from one individual to another. As a result, researchers addressing such a matter have come up with different assumptions about how WM mechanisms function, how they play a role in complex cognition, and how best to measure its capacity.

2.4.1. The Memory Span

Watkins (2003) defined the term memory span as "the maximum length of a sequence of items retrieved from a memory following a single presentation." (p.379). According to Bors and MacLeod (1996), the interest in memory span dates back to the publication of the pioneering study of memory made by the German experimental psychologist Hermann Ebbinghaus in 1885. Ebbingaus carried out a memory experiment using himself as his only subject to determine the number of presentation needed to reproduce an error-free sequence of items. The results showed that he could repeat in order a sequence of up to seven nonsense syllables (seven items) after one study period, while lists of greater length required several presentations. These serial learning experiments led to the emergence of tasks coined mental span, then later renamed memory span. Ever since, memory span was firmly embedded in the field of mental abilities testing.

Basically, the procedure of measuring memory span requires recalling items in the order in which they were presented. In some cases, the order of the items to be recalled is not compulsory; in other cases, the items should be recalled in the reverse order. In certain cases, however, the procedure requires more elaborate and cognitively demanding transformations. For example, recalling items in alphabetical or numerical order, or the last words in a given sequence of sentences. Such tasks are assumed to depend on the WM systems, which are also called the WM span tasks. Conway et al. (2007) affirmed that

> Several WM span tasks have been developed over the years, and they consistently show better predictive validity with respect to complex cognitive behaviours, such as reasoning, reading comprehension, and problem solving. […] They say something about how well people perform real-world cognitive tasks and they explain real-world variation in performance (p. 8)

2.4.2. Assumptions about Individual Differences in Working Memory Capacity

There is a general agreement among theorists that the WM is a limited-capacity mental workspace in terms of its ability to hold and process information. However, the exact nature of limits and the ways how to determine individual differences in working memory capacity (WMC) have been a hotly debated topic, and no consensus has been reached as to the particular sources of WMC limitations. Thereupon, various aspects of WM have been touched on including the storage capacity, the amount of information activated, the capacity of processing, and the allocation of resources to both processing and storage.

2.4.2.1. Daneman and Carpenter (1980)

Daneman and Carpenter (1980) developed a pioneering task to the study of the WMC in adults referred to as the Reading Span Task (RST). They required participants to read aloud sets of sentences, and then recall the last word in each sentence. The participants' performance on the task is expected to determine his or her WM span on the basis of the number of sentences that can be successfully processed and their final words recalled. Importantly, Daneman and Carpenter demonstrated that the reading span highly correlated with the capacity of their university students to read and comprehend prose passages.

2.4.2.2. Alternative Assumptions

In broader terms, WMC refers to the ability to manipulate information and resist distractions, and the ability to maintain activation of the items in WM over time. Alloway and Alloway (2013) defined the WMC as "the maximum amount of information and individual can maintain in a particular task that is designed to measure some aspect(s) of the WM system" (p. 25). In narrower terms, the controversy surrounding the issue of individual differences in WMC concentrates on whether there exists a unified overall system capacity or a specific capacity for each subcomponent (Cowan, 2005).

Dehn (2008, pp. 40-45) reviewed a synthesis of a broad variety of theoretical perspectives on the concept of WMC and how it could be determined.

2.4.2.2.1. The General View Hypothesis

Engle, Nations, and Cantor (1990) considered that WM performance is backed by shared resources that are divided by processing and storage. Understandingly, when the processing in performance on a given task is highly demanding, the capacity to store information decreases. For example, when trying to solve a complex arithmetic problem, capacity gets more limited and WM becomes overloaded. Consequently, information might be lost and the accomplishment of the task may become more difficult as the processing slows. Besides, this view assumes that WM is domain-general instead of task-specific. That is, there are no specific mechanisms of WM for reading and others for math; the same WM processes and functioning systems are recruited in a diversity of intellectual abilities. Other assumptions supportive of the general capacity hypothesis argue that the capability of task-switching determines general capacity. In other words, individuals may not be able to store and process information simultaneously. As a result, they should continually and quickly go back and forth between storage and processing. While storing, they are rehearsing the material to prevent information loss, and while processing the material in storage is ignored.

2.4.2.2.2. The Separate Resources Hypothesis

On the contrary to the notion that constrains on WM stem from the division of resources between storage and processing, other cognitive psychologists presupposed the existence of separate capacity limits for storage (STM component) and processing (the CE). Storage is limited by the number of chunks that can be memorised, whereas processing is limited by the number of ideas that can be operated on. This assumption is based on the belief that storage and processing demands are distinguishable. That is, the capacity of the CE has to

do with the rate of information processing, while STM span determines the storage capacity of the phonological loop and visuospatial sketchpad.

2.4.2.2.3. Efficiency Theories

Efficiency theories are divided into *specific processing hypothesis* and *general processing hypothesis*. First, the *specific processing hyp*othesis, originally proposed by Daneman and Carpenter (1980), postulates that WMC is task-specific. That is individual differences in WM are determined by processing efficiency rather than storage capacity. For instance, phonological loop span relies on the efficiency of phonological processing. Equally, the ability of someone to process language reflects his WMC. Accordingly, variance in individual differences in WMC depends on the task as well as the individual's processing proficiency at the task. To illustrate, a person who shows WM deficiencies at a reading task may display normal WMC while performing on a mental arithmetic task. Second, *the general processing hypothesis* predicates that general processing efficiency predicts the level of WM performance. This assumption is consistent with the aforementioned general view hypothesis in that the more processing systems are engaged; the more resources remain for brief storage. In addition, general processing efficiency is enhanced by the effective use of strategies when performing on a task in that individuals with high WM spans employ various and more effective strategies than those with lower spans.

2.4.2.2.4. LTM Activation Theories

Several theorists (Cowan, 2005b) believe that WM is intimately related to LTM. Accordingly, WMC is constrained by the capacity to sustain attention coupled with the ability to activate and retrieve information units stored in the LTM. Cowan supposed that attention could be sustained on approximately four activated long-term items at a moment in time. Besides, as the amount of activated information increases, processing decelerates. Therefore, individual differences in WMC are indicated by the number of long-term representations

which a person can activate at a point in time. Furthermore, the activation of items with the view that WMC is primarily determined by the number of ideas stored in LTM that can be maintained and manipulated concurrently.

2.4.2.2.5. Attention and Inhibition

This assumption relates the WMC to the controlled, focused attention while performing a cognitive task with the presence of interference and distraction. The loss of information from the WM is expected to be essentially the result of interference and disruption of attention instead of decay. That is, the functioning of WM is not tied to the size of short-term span or processing efficiency; but, rather, on the ability to sustain attention in order to satisfactorily fulfill the goals of a given task. Particularly, selective attention permits the entrance of only relevant information to WM systems, while it inhibits irrelevant information. Coequally, if irrelevant information is retained, interference takes place, which may lead to the slow of processing, reduction of span and a decrease in the efficiency of encoding and retrieval. The irrelevant information may be external (the environment), or internal (activation of material stored in LTM). When the ability to resist distraction and inhibit irrelevant material is inadequate such as in people suffering from Attention-Deficit/Hyperactivity Disorder (ADHD), the performance of WM would be significantly low, and hence a very limited WMC.

2.4.2.2.6. The Processing Speed and Task Duration Hypotheses

The speed of cognitive processing is regarded as another hypothesis developed to clarify how processing and storage are linked and how forgetting takes place. Research has revealed a close relationship between WMC and processing speed during the completion of a task. That is, as duration increases, the memory span decreases. This might be justified by the fact that higher processing speed makes the completion of a cognitive task faster and more efficient. Furthermore, slow processing results in extended retention interval which may lead

to the loss of items and the occurrence of forgetting. In such a way, the WM span is determined by the duration of processing.

Correspondingly, the conceptualization of WMC remains a complicated concern. There has been a plethora of converging and diverging views of the concept put forward in memory research. Essentially, the WMC is defined as a division of processing and storage when performing on a cognitive task, the capacity of task-switching or performing on two tasks simultaneously, processing efficiency, the effective use of strategies, the ability to sustain attention, the ability to activate and retrieve information stored in LTM, the ability to resist distractions and interferences of irrelevant information during the completion of a task at hand, and the speed of processing. Other controversies are concerned with whether WM is domain-general or task-specific. Evidently, none of the aforestated assumption would say everything about WMC; however, they leave open the possibility to acquire a deeper understanding of the concept regarding its paramount importance in human cognition. Conway et al. (2007) concluded that "individuals with greater WM capacity outperform individuals with lesser capacity in several cognitive domains, including complex learning, reading and listening comprehension, and reasoning." (p. 4).

2.4.3. The Most Common Working Memory Capacity Measurement Tools

The most active area of research investigating the aspects of WM emanated from studies based on individual differences in the capacity to store and process information. Consequently, the various assumptions about the WMC have led to the emergence of separate measures based on each view resulting in a variety of test batteries and measurement tools. According to Conway et al. (2007), the development of tasks primarily designed for the measurement of WMC significantly informed variation research. WM span tasks alongside other measures of WM functions, have been largely used to enquire individual differences in cognitive abilities in young adults, the development of WM and cognitive operating systems

in children, the deterioration of cognitive performance associated with aging, and impairments experienced by patients with brain damage or disease.

Richardson et al. (1996) supposed that one way of testing a specific hypothesis about the extent to which the limited capacity impacts cognitive functioning is to make comparison between individuals or groups who are assumed to differ in WMC. The research strategy is to carry out a measurement of WMC and to correlate their performance on that task with performance on other cognitive tasks under scrutiny, such as language-comprehension and production.

2.4.3.1. Tests of Working Memory Capacity

Regarding the variety of aspects of the WMC, several tests have been designed in research to measure each one of them. Conway, Macnamara and Engel De Abreu (2013, pp. 25-28) categorised the most frequently used test batteries designed to measure WMC.

2.4.3.1.1. Complex Span Tasks

So far, almost all measures of STM and WM that have been designed incorporate the measurement of span: the maximum number of serial information that a person can recall successfully. Principally, a span measurement procedure starts by presenting a subject with one or two items to remember in order. If subjects could recall the given items, the amount of information to be remembered is augmented.

Complex span tasks are used to measure WM operations based on the framework of Baddeley and Hitch (1974). They are basically dual-tasks; the subject is presented with material to be recalled and then engaged in a simple secondary task. That is, they involve effortful processing of information while trying to memorize a list of items. Common versions of the complex span tasks include the reading span task (Daneman & Carpenter, 1980), operation span (Turner & Engle, 1989), counting span (Case, Kurland & Goldberg, 1982), in addition to some other spatial versions (Kane et. al., 2004, Shah & Miyake, 1996).

Complex span activities depend on the executive functions of WM. For example, in the classic reading span task (Daneman & Carpenter, 1980), the examinee is given a set of sentences to read aloud, and then recall the last word in each sentence. Complex span tasks also rely on the focus of attention and the active maintenance of information. For instance, in the counting span task, the subject is given an array of objects demonstrated on a computer screen. The objects differ in shape and colour; for example, squares and circles coloured in red and green. Afterwards, the subject is asked to count aloud a specific type of object; for example, green circles and then recall their total number in correct serial order after all the arrays have been demonstrated. Thus, the task demands the focus of attention while trying to memorize the digits in the presence of attention disruption. Or, in other words, it requires the coordination of both storage and processing.

Furthermore, the different versions of complex span tasks have the same structure but differ in the type of information to be retained (digits, letters, words and spatial locations) as well as the type of secondary task to perform on (counting, reading and comprehending sentences, solving simple math problems, and deciding whether a given figure is symmetrical or not). Dehn (2008) indicated that such activities have shown high correlation with academic learning and complex cognitive operations.

2.4.2.1.2. Simple Span Tasks

Simple span tasks are among the oldest tests known in memory research. They were also incorporated in the earliest intelligence tests and remain to date to be involved in two widely used intelligence tests: the Wechsler tests (WAIS and WISC). The commonly used versions of such tasks are the digit span and the letter span tasks. On the contrary to the complex span tasks, the simple span tasks do not involve a secondary task between the presentations of material to be recalled. For example, in digit span, the examinee is presented

with only one digit at a time, generally one per second, and after a sequence of digits he or she is required to recall the digits in correct sequential order.

Nevertheless, performance on simple spans does not have strong correlations with measures of cognitive ability because individual differences in such activities are revealed by domain-specific mechanisms. Dehn (2008) argued that "simple span is presumed to measure short-term memory. […] Measures of simple span require only the passive retention of information." (p. 132).

2.4.2.1.3. Visual Array Comparison Tasks

A weakness attributed to both simple and complex span tasks is that they are not precise measures of the amount of information an individual can maintain active at one point in time because the presented items should be recalled one at a time, and consequently performance may result in interference. By way of explanation, an examinee might obtain a score of three on a memory span task but it is imaginable that more than three items were kept active. Some demonstrated items may fade.

Alternatively, the visual array comparison task was developed by Luck and Vogel in 1997 as measuring tool of memory capacity. There exist multiple formats of the test. In an exemplary version, the subject is presented with an array of several that differ in shape and colour for a very short period (a fraction of a second). After a brief memorization interval, possibly one second, the subject is shown a second array and requested to decide whether the two arrays were similar or different. In a first part of the two arrays are similar and in the second half one item in the second array is different. Therefore, if the subject can maintain all the items in the first part, then he will be able to detect the point of difference. Generally, the subject obtain 100% accuracy when the number of items is less than four but performance starts to get lower as the number of items in the arrays exceeds four.

In fact, visual array comparison tasks have not been widely used to enquire differences in cognitive abilities. However, recent research has illustrated that such activities could reveal as much variance as complex span tasks do.

2.4.2.1.4. N-Back Tasks

The n-back task is another popular test especially used in cognitive neuroscience. The procedure of the test is that the subject is shown a sequence of stimuli, one at a time, often one stimulus very two to three seconds. At the end, the subject is required to remember a previous presentation. For example, using a set of cards containing numbers in a 2-back task, the subject is asked to recall the number on the card that was shown on two cards prior to the one currently presented. If the presentation sequence is "10", "2", "6", "8", the subject is expected to recall "10" when the "6" is presented and "2 when the "8" is presented. The n-back task is primarily employed to measure executive functioning. However, its validity as measure of WMC was later criticised for it does not significantly correlate with tests of WM span.

2.4.2.1.5. Coordination and Transformation Tasks

The majority of WM tasks expect an examinee to remember or recognise items that were explicitly shown, typically on cards or computer screens. In parallel, there is another type of WM task termed *coordination and transformation*in which examinees are shown items and asked to manipulate and transform them to fulfill the measurement objective. One task that falls under this category of tests is "the backward span" task. Principally, it is similar to the simple span task except that the examinee is asked to recall the presented items, for example a list of digits, in reverse order.

In cognitive research, performance on the coordination and transformation tasks is considered a reliable measure of WMC. As well, strong correlations have been revealed between WMC and reasoning using this category of test.

2.4.3.2. Interviews

Interviews are widely used research tools in a multiplicity of disciplines. They are qualitative methods of inquiry that are basically designed to elicit the interviewees' opinions and beliefs about a particular topic. In memory research, they might be used as comprehensive psycho-educational assessment instruments structured either to direct testing procedures or to acquire a deeper understanding of the interactions between the variables and help adequately explain test results. Conventionally, interviews can be divided into several types based on the degree of the structure in the process or the number of sessions an interview might involve. Dorneyi (2007) categorised them into: highly structured versions of interviews, which are very similar to quantitative written questionnaires, structured interviews, semi-structured and unstructured interviews.

According to Dehn (2008), interviews are rarely used to specifically enquire WM as a well-defined domain, but supposedly they may be very convenient to produce richer descriptions necessary for worth-while findings obtained from tests of some aspects of WMC. He suggested three types of interviews: teachers' interviews, students' interviews and parent interviews. Teacher interviews focus on specific academic learning concerns which should be clarified at the beginning. Then, proceed with lists of questions to be covered closely with a teacher of a particular subject matter about the performance of students on particular tasks which are thought to depend on WM operating systems; for example, solving maths problems, reading and language comprehension, and reasoning. Such interviews are expected to elicit teachers' hypotheses in terms of the students' learning problems.

Interviews may be conducted with parents to obtain valuable information about a students' WM functioning. Parents are expected to be very conscious and informative about their child's learning and memory processes especially if he s/he faces learning difficulties.

The questions involved in such a sort of interview should be relevant to WM functioning; for instance, performance on multistep tasks, strategy use, and speech and language development.

Interviews may also be administered as enquiry methods employed to assess students' WMC. Students can be directly asked about their learning behaviour and difficulties they frequently encounter and that seem to depend on WM operating systems. However, the interviewer should use age-appropriate terminology and focus on the areas that students are sufficiently aware of.

Finally, the use of interviews may yield valuable answers that would provide a profound understanding of the WM functioning and how it may affect learning. Besides, they may help to develop strategies and interventions designed to enhance WM. However, they remain only complementary research tools and should not be used alone. Dehn insisted that "Information obtained from interviewing should never be used alone to confirm hypothesesor reach diagnostic decisions. Rather, interview data need to be corroboratedby other assessment data before their accuracy is accepted." (p. 147).

2.4.3.3. Observations

Observation of a subject's behaviour may equally serve as research tools for enquiring and assessing WM. Fundamentally, to ensure the reliability of such a tool, the observer should be adequately informed about WM and its implications in performance on cognitive tasks, its limitations and impairments. Dehn (2008) emphasized that an observer ought to examine the processing demands of a cognitive task a subject is engaged in and then make inference from his or her behaviour. Observations may be conducted during the administration of a WMC standardized test to achieve an in-depth understanding of WM strengths and weaknesses and how the subject deals with the cognitive demands of a given task. Likewise, observations may be carried out in classrooms to learn about students WM characteristics during the accomplishment of a variety of learning tasks. Additionally, they may provide insights about

how the instructional material may impact the students' WMC; specifically, the strategy use to tackle tasks as well as the amount of cognitive load that learning activities might involve.

2.5. The Working Memory and Academic Learning

In the educational and psychology literatures, the WM is assumed to be a powerful indicator of scholastic achievement as well as learning difficulties. Nearly every characteristic of the components of the system: the phonological loop, the visuo-spatial sketchpad, the episodic buffer and the central executive is implied in academic learning from childhood to the adulthood. Moreover, its capacity to manipulate and store information is believed to determine learning strengths and weaknesses in such areas as mathematics, language processing, reading comprehension and written language. Dehn (2008) affirmed that "nearly all of what must be learned and remembered must pass through WM. Hence, the capacity and effective functioning of WM determines the rate and extent of learning." (p. 92). Equally, Alloway (2006) claimed that individuals with poor or deficient WM are most likely to struggle and often fail to cope with the learning demands of a wide range of classroom activities. Thus, learning difficulties presumably emanate from the inefficient use of WM potential. Nevertheless, theorists indicated that poor WM performance is attributed not only to capacity but also strategy use. Dehn (2008) theorised that "students with a learning disability often possess sufficient WM resources and the ability to apply effective strategies but fail to use these strategies spontaneously or consistently." (p. 96).

2.5.1. Working Memory and Oral Language

The capacities of the whole WM system and the amount of temporary storage capacity have significant implications for oral language comprehension and production. Dehn (2008) stated that "oral language production places demands on WM, especially during the conceptualizing and sentence formulation stages." (p. 99). Thus, a speaker is not only

expected to retrieve words but also ensure the grammatical accuracy of a production which depends on both storage and manipulation of verbal information.

2.5.2. Working Memory and Reading

Research has revealed a strong relationship between the performance of WM and reading skills. Alloway (2006) indicated that "reading disabilities can be characterized by marked difficulties in mastering skills including word recognition, spelling and reading comprehension." (p. 135). Dehn (2008) made a distinction between two categories of skills which both draw on WMC: reading decoding and reading comprehension. On the one hand, reading decoding, also termed *basic reading skills* relies essentially on phonological processing; that is, that ability to detect and process speech units (phonemes). This type of skill draws from STM, LTM and WM. Particularly; it is linked to phonological STM and verbal WM. On the other hand, reading comprehension is more sophisticated and requires higher levels of cognitive processing. Such a skill is closely dependent verbal WM, executive WM and LTM.

The most frequently used measurement tools to enquire the implication the WMC in reading comprehension are the complex span tasks such as the Reading Span Task developed by Daneman and Carpenter in 1980. Alternatively, the basic reading skills are generally measured by means of simple span tasks which primarily focus on STM abilities.

2.5.3. Working Memory and Written Language

Writing, as a language production skill, is another complex cognitive process that banks on multiple cognitive processes including memory. According to Dehn (2008), writing involves a number of stages initiated by a brainstorming phase during which the writer attempts to generate thoughts and build a preverbal message that is relevant to the idea s/he or she intends to deliver. Afterwards, the writer tries to transform the ideas into words and build grammatically accurate sentences that require retrieval of the semantic, syntactic, and

morphological properties of lexical units. Once making a draft, the writer is supposed to judge what s/he has written by comparing the text with the message to be transmitted. All these stages rely on WM; particularly, the executive and verbal components. In addition, the brainstorming stage places demands on the visuospatial component as writers often need to visualize or create a picture in mind of what they want to write about.

2.5.4. Working Memory and Mathematics

More recent evidence has revealed a strong association between the performance of WM and the acquisition of mathematical knowledge and skills. Alloway (2006) reported that "mathematical deficits could result poor WM abilities […] low WM scores have been closely related to poor computational skills." (p. 136). Evidently, performing on mathematical tasks requires high levels of cognitive processing that apparently recruits WM functions. A typical example, in an attempt to multiply 7 by 5, without using a pen and paper, an individual needs to hold the two numbers and use multiplication rules to calculate the result 35. Such an arithmetic task requires both holding and manipulating informative knowledge to perform on the task adequately.

Dehn (2008) divided mathematic skills into two types: basic arithmetic calculation and mathematics problem solving. He argued that both types heavily rely on three WM processes: brief storage to maintain problem information, retrieval that accesses relevant procedures and processing operations that transform information into numerical output.

2.6. Working Memory and Intelligence

Recent developments in cognitive research have demonstrated a strong link between the WM and intelligence which act as two interconnected cognitive mechanisms that underlie complex cognition including reasoning, reading, problem-solving, rehearsal and chunking. Specifically, empirical works have made a link between the WMC and fluid intelligence Conway et al. (2011), in a thorough investigation to understand the functional and neural-

mechanisms implied in intelligent information processing, have found that measures of WMC strongly correlate with measures of fluid intelligence. Initially, they made a distinction between two types of intelligence: fluid intelligence and crystallized intelligence. The former refers to one's fluid abilities to think abstractly, reason and solve problems, while the latter has to do with acquired knowledge from past experience. Next, they emphasized that WMC is more related to fluid intelligence because WM is most essential in situations that do not necessitate prior knowledge but rather in situations in which skills and strategies direct behaviour. Further, they reported two recent meta-analyses, carried out by two different groups of researchers, provided estimates of the correlation between WMC and fluid intelligence as   r= .72 (Kane et al., 2005, In Conway et al., 2011), and r= .85 (Oberauer et al. , 2005, In Conway et al., 2011); the studies have revealed strong relationships between performance of subjects on a number of WMC tasks such as the complex span task, the simple span task, attention tasks and N-back tasks with a batteries of tests designed to measure fluid intelligence including arithmetic reasoning, grammatical reasoning, following instructions, problem-solving, computational reasoning, and verbal analogies. Finally, they concluded that the cognitive mechanisms underlying WMC and fluid intelligence primarily embrace goal maintenance, selective attention, interference resolution, active maintenance and controlled retrieval from LTM. Accordingly, they argued that such a relationship indicates that WMC imposes a constraint on intelligence. So, an enhancement of WMC presumably leads to an increase of intelligence level.

Conclusion

Memory is deemed to be one of the most complex constructs in human cognition and continues to be an extremely active area of research. Abundant inter-disciplinary research endeavours conducted in philosophy, cognitive psychology, educational psychology, and neurology has led to the conceptualization of several models of memory; these include:

sensory memory, short-term memory, long-term memory and working memory. The WM model is assumed to be a limited-capacity mental workspace responsible for maintaining, manipulating information, directing attention and resisting distractions. It plays a central role in the accomplishment of a myriad of complex cognitive tasks including attention, planning, problem-solving, reasoning, and decision-making, intelligence and language comprehension. It was first proposed by Baddeley and Hitch in 1974. Ever since, the model is still under refinement to deepen understanding of its mechanisms and capacity. The WMC is believed to be a powerful predictor of scholastic achievement as well as learning difficulties as far as it has significant implications in such areas as language comprehension and production and mathematics. A central issue addressed in memory research is the measurement of working memory capacity. As such, a number of tools have been developed to attain such an objective; these involve tests, interviews, observations and cognitive scales.

Chapter Three

Lexical Knowledge Development

Introduction

Words are undeniably the basic constituents of human language; they indeed make up a substantial portion of the very human activities, namely communication and learning. Ivan Pavlov accentuated the significant value of words stating that, "It is nothing other than words which has made us human." (Pavlov, 1941, In Halliday, 2011, p. 6). Therefore, acquiring vocabulary knowledge is deemed an absolute necessity to learn and master a language. It was until recently, however, that the area of vocabulary has been given attention to in language education research because emphasis was relatively laid upon grammar and phonology. As a result of shifts of focus, a growing body of research in linguistics and other related disciplines including psychology, sociology and cognition, has been carried out to address numerous issues related to the acquisition and development of lexical knowledge. Enquiries conducted in such a vast linguistic arena have yielded numerous assumptions and theoretical insights about the concepts in vocabulary and lexical knowledge, the processes and mechanisms involved in vocabulary learning and acquisition, the place of vocabulary in language learning and teaching, and how it can be measured. Nonetheless, no consensus has been reached about numerous issues, and the door remains open for further investigations on how humans acquire, develop and use word knowledge.

3.1. The Lexical Knowledge

3.1.1. The Significance of the Lexicon

Wilkins (1972, p. 111) emphasized the importance of vocabulary, as an essential language component, stating that: "without grammar little can be said; without vocabulary nothing can be said." Notwithstanding, Up to the late 1980s, the status of vocabulary was relatively lower in linguistic research; priority was rather given to grammar and phonology as basic features of the language structure. However, by the early 1990s, reactions against such a view started to emerge owing to the dramatic increase in enquiry about vocabulary.

According to Decarrico (2001), the revival of interest in vocabulary was motivated by the recent contribution of computer-aided studies which analysed the use of words in authentic settings that became to be known as language corpora, as well as the research findings yielded in psycholinguistics about the cognitive processes involved in vocabulary acquisition. Consequently, a myriad of studies were undertaken to acquire a deeper understanding of the processes of vocabulary teaching and learning and assessment in both natives and foreign language learners. Meara (1982) reported that

> This neglect is all the more striking in that learners themselves readily admit that they experience considerable difficulty with vocabulary, and once they have got over the initial stages of acquiring their second language, most learners identify the acquisition of vocabulary as their greatest source of problems. (p. 100).

3.1.2. The Complexity of the Concept 'Word'

At the simplest level, the vocabulary of a language is made up of words or vocabulary items. So, as a starting point to understand the structure of the lexical system of a language is to determine what exactly is meant by the term 'word' or '*lexis*' (the Greek for *word*), which remains one of the challenging issues addressed in lexical research from the outset since there is no consensus among scholars about its precise definition. Carter (1998, p.8) pointed out that "it is clear that the uses of the words word or vocabulary have a general common-sense validity and are serviceable when there is no real need to be precise." By the same token, Schmitt (2000) emphasized that "[…] for anyone interested in exploring the subtlety and magic of lexis, the term *word* is too general to encapsulate the various forms vocabulary takes." (p. 1). By way of explanation, the complex and multifarious nature of the concept 'word' could be justified by the multiplicity of its properties: orthographic, morphological, syntactic, phonological, semantic, pragmatic, and that the word is an idiosyncratic component

in language. As a result, several attempts have been made by linguists and lexicographers to alleviate the ambiguity in the notion of 'word'; several terms have therefore been coined for the concept; and several working definitions and categories have been proposed.

From an orthographic perspective, Carter (1998) defined the term word as "any sequence of letters (and a limited number of characteristics such as hyphen and apostrophe) bound on either side by a space or punctuation mark)". (p. 4). Nevertheless, this definition was later criticized by Takac (2008), who claimed that "it is formalistic, inconsistent and incomplete because it neglects differences in meaning and the issues of polysemy, homonymy, grammar functions, etc." (p. 5). Another definition, from a semantic point of view advocated by Bloomfield, suggested that a word is "the smallest meaningful unit of language." (Carter, 1998, p.5).

Nevertheless, the existence of some irregularities related to words' forms and meanings remains a reason behind the authors' reluctance to define the term *word*. Read (2000) raised the question "does vocabulary consist of single, or should we be thinking in terms of larger lexical items as well?" (p. 17). This implies that the existence of larger lexical units such as phrasal verbs like *get across, move out, put out with*, compound nouns like *fire fighter, aircraft, brainstorm*, idioms including *kick the bucket, let the cat out of the bag, by hook or by crook*, which all consist of several lexical units but devote one meaning, makes the task of defining the term quite confusing.

Schmitt (2000, P. 2) addressed another problematic case; he stated that "it is not that clear whether *walk*, *walked*, *walking* and *walks* should be counted as a single word or four. Likewise, are *stimulate*, *simulative* and *stimulation* the same word?" In the given example, both sets of words involve a root word with its inflections and/or derivations, referred to as word families. In such a case, the words have different forms but relate to the same meaning.

The grammatical and morphological dynamicity of these lexical units complicate the task, particularly for lexicographers, to classify them as single or various lexical units.

Skiljan (1994, In Takac 2008) defined a word as "a combination of morphemes that comprise a firm unit suitable for the formation of higher level units." But this raises another lexical dilemma that is the existence of individual words devoting several meanings. For example, the word *bank* which means "(1) An organization that provides various financial services, for example keeping or landing money"; or "(2) "the side of a river, canal, etc; and the land near it". (Oxford Dictionary, 2005). Carter (1992, In Takac 2008) asserted that "one of the greatest problems of defining a word […] is the fact that words have different forms that would *not* be intuitively regarded as different words. Words can have the same form with completely different but unconnected meanings."

As a result, by way of resolving the problem of what to consider as a word, the term *lexeme* (also *lexical unit* or *lexical item*) was proposed. Schmitt (2000, p. 2) defined a lexeme as "an item that functions as a single meaning unit, regardless of the number of words it contains." Similarly, Carter (1998, p. 8) postulated that "*lexical item(s)* (or sometimes *vocabulary items* or *simply items*) is a useful and fairly neutral hold-all term which captures and, to certain extent, helps overcome instabilities in the term word."

In sum, McCarthy, O'keeffee and Walsh (2010) summarized that

> Words are more than mere individual containers with meaning. They exist in a complex matrix which links them to morphemes (prefixes and suffixes), other meanings (synonyms and antonyms), and other words (the words they are likely to occur with or associated with), grammar patterns, multi-word units (groups of words that are fixed into phrases or idioms). (p.vii)

3.1.3. Word Categories

In an attempt to decipher the intricacies of lexical knowledge; particularly what is conceived as a word, lexical items have been classified into sets of categories.

3.1.3.1. Single Words

3.1.3.1.1. Tokens, Types, Lemmas and Word Families

Nation (2000) made a distinction between four word categories that basically has applications to counting words in written and spoken texts.

First, *Tokens*, also referred to as *runningwords*, refer to the total sum of word forms involved in a spoken or written text. That is, to determine the number of tokens in a text, every individual word is counted even if it occurs more than once. For example, the sentence "the boy brought the broken toy" contains six tokens, even though the word "the" occurs twice.

Second, *Types* is a category in which we count the number of different words in a text, so that a word which occurs more than once is not counted. Thus, the sentence "the boy brought the broken toy" contains five types (the determiner "the" is counted only once).

Third, a *lemma* involves a headword (a base word) and a set of its inflected forms. For instance, the lemma of the verb *work* would include *works*, *worked*, and *working*. However, the inflections should not change the meaning of the base word; by way of explanation, all the items classified under the same lemma should belong to the same part of speech. So, in the given example, the word "workable" (which is an adjective) does not belong to the lemma *work* (which is a verb).

Fourth, a *word family* is made up of headword (a base word), its inflections and a variety of its derived forms. As a typical example, the word *use* (a headword), with its inflections *uses*, *used* and *using* as well as its derivations: *useful*, *usage*, which are closely related in form and meaning, can be classified under the same word family.

3.1.3.1.2. Function Words vs. Content Words

Carter (1998) divided lexical items into two categories: function words and content words. On the one hand, function words, also known as empty words or "functors", are words which have to do with the grammar of the language rather than with its vocabulary; that is to say, they carry lower information content when used in isolation. It is a relatively limited class of words involving articles (the, a, an), prepositions (up, down, in), pronouns (I, you, me), conjunctions (and, but, for), and auxiliary verbs (must, could, shall). On the other hand, content words, also referred to as lexical words or full words, make up a larger and potentially unlimited class of words. They include nouns (man, cat), adjectives (beautiful, brilliant), full verbs (find, wish), and adverbs (fast, luckily). Such a category of words have a more accessible meaning in isolation and basically serve to build up sentences. Read (2000, p.18) stated that "when we set out to test vocabulary, it is knowledge of content words that we focus on." This reflects the significance of content words as part of an individual's lexical knowledge. Further, according to Carter (1998), content words are more prone to change through the historical development of languages, or what linguists refer to as diachronic change, unlike the grammatical words which remain more stable.

3.1.3.2. Multi- Word Units

As discussed earlier, the existence of multi-word units that are recurrently used as single words is another source of confusion when it comes to define the concept 'word'.

3.1.3.2.1. Compounds

McCarthy et al. (2010, P. 51) defined a compound as "simply a word that is made up of a root form and other 'add-ons', which may be other words or affixes." So, one way to have a compound is by affixation (adding a prefix and/or suffix to the beginning or the end of a root word). For instance, the word *disrespectful* consists of the root *respect*, the prefix *dis-* and the suffixe *-ful*. Futher, linking these lexical pieces results in changing both the form and

the meaning of the word. In the given example, the noun *respect* changes into the adjective *disrespectful*. Another way of constructing a compound is by adding a word: a noun, a verb, an adverbial as illustrated in the following table:

Table 3.1. Some Examples of Compound Words (McCarthy, 1990, p. 7).

Noun + noun	bedroom, motorcycle, policeman
Adjective + noun	greenhouse, hardhat, software
Verb+ noun	washing machine, pushchair, swimming pool
Verb + verb	make do
Adverb +verb	output, input, upturn

3.1.3.2.2. Prepositional Phrases and Phrasal Verbs

According to McCarthy et al. (2010), a prepositional phrase is "a string of words that is treated as a single lexical unit. It is composed of a preposition plus a noun phrase and often indicates a place of time: *'at the end of the day'*, *'from time to time'*, 'from *here to eternity',* *'forever and ever'* " (p. 53).

Equivalently, phrasal verbs are combinations of verbs with other grammatical words such as prepositions and adverbs, which alter both form and meaning. For example: *tolook after* (take care of somebody or something), *tocall off* (to canceal),   *to bring up* (to raise a child).

3.1.3.2.3. Idioms, Binomials and Trinomials

In the English language, idioms are a set of recurrently used expressions like '*tokick the bucket'* (to die), ' *raining in cats and dogs'* (to rain heavily), '*let the cat out of the bag'* (to reveal a secret). Gairns and Redman (1986) defined an idiom as "a sequence of words that operate as a single semantic unit, and [...] the meaning of the whole cannot be deduced from

an understanding of the parts." (p. 35). Equally, Schmitt (2000) referred to an idioms as "a string of words which taken together has a different meaning than the individual component words." (p. 1). McCarthy et al. (2010) added that "idioms have figurative (non-literal) meanings. These meanings have developed and become 'fossilized' over long periods of time." (p. 67). Accordingly, an idiom is an expression which comprises several words but functions as a single lexical item whose meaning is usually figurative rather than literal. One characteristic of idioms is that they are fixed, syntactically-restricted expressions, so the meaning conveyed by each idiom might change if we change its structure or constituent parts (i.e. we say '*kick the bucket*', but not '*hit the bucket*' or '*throw the bucket*—other forms are not permissible). Another characteristic is that idioms differ in the clarity of meaning they convey. That is, some idioms have a transparent, deducible meaning. For example, *give someone a hand* (means to help someone). Conversely, other idioms are semantically ambiguous with a barely deducible meaning. For instance, the expression: '*to have several irons in the fire*' (means to have several jobs at the same time).

By the same token, Binomials and trinomials are also fixed, frequently used expressions treated as single words. McCarthy (1990, p. 8) described them as "pairs and trios of words which display fixed membership and sequence which, like idioms, should be treated as single vocabulary items." Examples of some binomials, in English, might include*: 'back to front'*, '*wine and dine*', '*ladies and gentlemen*', '*clean and tidy*', '*loud and clear*', and so on. Trinomials refer to such expressions as '*cool, calm and collected*'; '*ready, willing and able*'; '*morning, noon and night*'; '*lock stock and barrel*'.

3.1.3.2.4. Lexical Phrases

Nattinger and Decarrico (1992, pp.38-47, In Read, 2000, p. 22) have introduced the concept lexical phrase, which refers to a combination of words that resembles a syntactical

structure but functions as a single unit. They classified such a sort of lexical entities under four categories:

● **Polywords:** short fixed phrases that perform a variety of functions, such as *'for the most part'* (which they call a qualifier), '*at any rate'* and '*so to speak'* (fluency devices), and '*hold your horses'* (disagreement maker)

● **Institutionalized expressions:** longer utterances that are fixed in form and include proverb, aphorisms and formulas for social interaction. Examples are: '*a watched pot never boils',* '*how do you do?',* '*long time no see',* '*once upon a time',* '*they lived happily ever after.'*

● **Phrasal constraints:** short-to-medium- length phrases consisting of a basic frame with one or two slots that can be filled with various words or phrases. These include   a [*day/year/long time*] ago, yours [*sincerely/truly*], as far as I [*know/ can tell/ am aware*], and the [*sooner*] the [*better*].

● **Sentence Builders:** phrases that provide the framework for a complete sentence, with one or more slots in which a whole idea can be expressed. Examples are: I think that X; not only X, but also Y, and that reminds me of X."

Likewise, Pawley and Syder (1983, pp. 206-208, In Read 2000, pp.22-23) provided a list of longer recurrently used expressions of such a type. It includes expressions like "*it'*s *on the top of my tongue*; *have you heard the news*, *I'll believe it when I see it*; *she never has a word to say about anyone*, and *call me as soon as you get home.*"

In other references, like in McCarthy et al. (2010), this category of multi-word units, frequently treated as single words, is also called lexical chunks. They are divided into semi-fixed and fixed expressions. They usually include discourse markers (*by the way, what's more, even so*); social formulae used to establish channels of communication in conversations (*how's it going, see you soon, I was wondering if*); and sentence builders (*the thing is, what I mean is, if you ask me*)

Read (2000) argued that knowledge of utterances of such a type has a lot to do with the fluency of speakers and writers, and that the task of achieving an ability to speak a language fluently depends on the memorization of thousands of such sentences that are considered by scholars as single lexical units. Besides, this assumption called into question the dominant view of the linguist Noam Chomsky that linguistic competence requires knowledge of a system of grammatical rules that enable the language user to comprehend and produce an almost endless number of possible sentences.

3.1.4. Lexical Relations

As seen earlier, words are not isolated components of the language. Gairns and Redman (1986) stated that "the meaning of a word can only be understood and learnt in terms of its relationship with other words in the language." (p. 22). Therefore, words function in association with other words; moreover, grasping the organizational structure of vocabulary requires knowledge of the relationships that tie words. The most pervasive relationships include synonymy, antonymy, polysemy, homonymy, hyponymy.

3.1.4.1. Synonymy

According to McCarthy et al. (2010, P. 75), synonymy accounts for "where two or more words have the same meaning; that is, where one can substitute for the other without altering the meaning." For example, the words *large* and *big*, *start* and *begin*,*fast* and *quick* are said to be synonymous words that convey an equivalent meaning. However, some synonyms cannot always substitute each other in particular contexts even though they share the same meaning. A typical example might be the two words *opposite* and *contradictory*: one may say: '*I walked in the opposite direction*', but not '*I walked in the contradictory direction*'. The use of the synonyms can also be influenced by the register--the degree of formality of the context; for instance, the case of the words: '*conversation*' (formal) and '*confab*' (informal). A further limit on the use of synonyms is collocation--the words with

which they co-occur in certain contexts. For example, the word *quick* cannot substitute the word *fast* in the phrase '*fast food*', though they mean the same.

3.1.4.2. Antonymy

Conventionally, antonyms are words that have different or opposite meanings. Nonetheless, there exist various forms of oppositeness. Gairns and Redman (1986) examined these relations and classified antonyms under four categories. First, complementaries (also termed binary antonyms) are pairs of words that are opposite in meaning, cannot be graded, and the application of one pair excludes the other. For example: *male/female*, *dead/alive*, *true/false* are complementaries. Second, converses are pairs of words that share a reciprocal relationship and can paraphrase each other. Converses are pairs like '*husband/wife*', '*niece/nephew*', '*night/day*', '*above/below*'. Third, gradable antonyms refer to pairs of words, generally adjectives, which serve as two extremes of a scale comprising other related words whose characteristics lie on a continuous spectrum. Typical example pairs may involve '*good/bad*', '*hot/cold*, '*tiny/huge*', '*expensive/cheap*'.

Figure 3.1. Example of gradable antonyms "tiny/ huge" (McCarthy, 2010)

Tiny ⟶ small ⟶ medium-sized ⟶ big ⟶huge

Fourth, multiple-incompatibles (also coined multiple taxonomy) are groups of field-related words, usually fixed in number. For example, seasons of the year (*summer/autumn/winter/spring*), directions (*north/south/east/west*), and a suit of cards (*diamonds/hearts/spades /clubs*). Practically, using one word from the group excludes all the others.

3.1.4.3. Hyponymy

McCarthy (1990, p.19) characterised hyponymy as "a relationship of inclusion, organizes words into *taxonomies*, or hierarchical diagrams." So, the word '*vehicle*' can include a number of hyponyms such as '*car*', '*van*', '*lorry*', and '*pick-up*', which are all called co-hyponyms, of the same super-ordinate term. The reverse relationship is called hyperonymy (i.e. '*vehicle*' is a hypernym of '*car*'). The word "car" itself can be divided to include further hyponyms such as "hatchback", "saloon", and "coupé".

Figure 3. 2. A taxonomic Diagram of hyponymy (McCarthy, 1990)

```
                        Vehicle
             Car        van      lorry    pick-up
     Hatchback   saloon  coupé
```
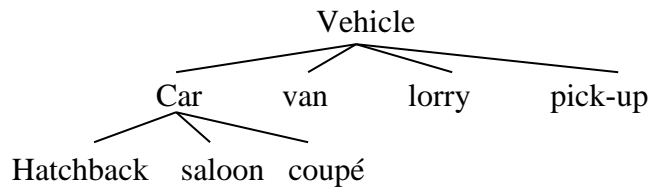
3.1.4.4. Polysemy

Carter (1998: p. 12) considered that polysemy is "the existence of several meanings in an individual word". In fact, one word rarely conveys one single meaning. Lexicographers classify words that have multiple, but related, meanings as polysemes. An example of this type of words is the word "*line*" which has several meanings including: "(1) long thin mark; (2) division; (3) shape; (4) row of people/things; (5) series; (6) words; (7) rope/wire/pipe; (8) telephone; (9) railway/railroad; (10) attitude/argument; (11) route/direction; (12) activity; (13) product; (14) transport; (15) soldiers." (Oxford Dictionary).

3.2. Aspects of Lexical knowledge

Alongside the question of what lexical items are made up of, another important issue addressed in vocabulary research is to determine 'what it means to know a word'. In layman's terms, knowing a word consists of knowing its form and meaning. However, the potential

knowledge that can be known about a word might have a rather richer and more complex nature. This can be justified by the fact that words are not likely to occur in isolation. Besides, the vocabulary of a language is not absorbed instantaneously,but rather in a gradual manner which suggests the existence of various degrees of a multi-faceted knowledge. Accordingly, lexical researchers have made thorough attempts to conceptualize what is globally involved in lexical knowledge required to use a word properly and effectively enough in a wide variety of language situations.

One of the earliest conceptualizations of word knowledge was Dales's (1965, cited inn Reard 2000, p. 27) developmental scale representing the extent to which a person could understand a word. It comprises four basic stages:

1. Stage 1: ' I never saw it before.'
2. Stage 2: 'I have heard it, but I don't know what it means.'
3. Stage 3: 'I recognize it in context- it has something to do with …'
4. Stage 4: ' I know it.'

These stages are considered as the degrees of partial lexical knowledge that an individual can have of words he knows in relation to context.

Beck, Mckeown, and Omanson (1987, In Wagner et al. 2007, p.9) assumed varying degrees of word knowledge that could be represented on a continuum. This includes

> 1. No knowledge. 2. General sense such as knowing *mendacious* has a negative connotation. 3. Narrow, context-bound knowledge, such as knowing that a "radiant bride" is beautiful and happy, but unable to describe an individual in a different context as "radiant". 4. Having knowledge of a word but unable to recall it readily enough to use it in appropriate situations. 5. Rich, decontextualised knowledge of a word's meaning, its relationship to other words, and its extension to metaphorical uses, such as understanding what someone is doing when they are "devouring" a book.

Scales of this kind are based on the idea that a person can make a general sense of a word without having an explicit knowledge of the word ot its meaning.

Graves (1987, cited in Wagner et al. 2007) identified the aspects of vocabulary knowledge based on the view of tasks undertaken by a person throughout the stages of acquiring lexical items:

> 1. Learning to read known words. 2. Learning new meanings for known words. 3. Learning new words representing known concepts. 4. Learning new words for new concepts. 5. Clarifying and enriching known words and meaning. 6. Moving words from receptive to expressive vocabulary.

Indeed, these stages also mirror the incremental nature of the process of acquiring vocabulary. That is, how a person acquires different sorts of word knowledge throughout an extended period of time.

Richards (1976, In Read, 2000, p.25) prompted to spell out what learners should know about a word if they are to fully acquire it. He devised a series of assumptions emanating from growing trends in linguistic theory towards lexical competence in the 1960s and 1970s. The list of assumptions was regarded as a general framework of vocabulary knowledge and covers the following aspects:

> 1. Knowing a word means knowing the degree of probability of encountring that word in speech or print. For many words we also know the sort of words most likely to be found associated with the word. 2. Knowing a word implies the limitations on the use of the word according to variations of function and situation. 3. Knowing a word means knowing the syntactic behaviour associated with the word. 4. Knowing a word entails knowledge of the underlying form of a word and the derivations that can be made from it. 5. Knowing a word entails

knowledge of the network of associations between that word and other words in the language. 6. Knowing a word means knowing the semantic value of a word. 7. Knowing a word means knowing many of the different meanings associated with the word.

3.2.1. Dichotomies of Word Knowledge

3.2.1.1. Breadth Vs. Depth of Word Knowledge

Milton (2009) presented a further convention regarded convenient in vocabulary acquisition research. A distinction is made between two major dimensions of vocabulary knowledge: *breadth* of word knowledge and *depth* of word knowledge. On the one hand, *breadth* designates the number of words a learner knows, or stores in his or her lexical repertoire. On the other hand, depth indicates what the learner knows about words, or the richness of word knowledge as well as the degrees of awareness of the features of lexical items. However, it has been argued that such a distinction might lead to confusion. For instance, vocabulary breadth may embrace the passive recognition of the word forms when seen or read in a foreign language, but without being able to give the meaning or a translational equivalent.

3.2.1.2. Receptive Vs. Productive Vocabulary Knowledge

Nation (2000) suggested a more complete and systematic dichotomy of word knowledge deemed rational in the lexical research literature. It involves knowledge of three areas: knowledge of *form*, knowledge of *meaning* and knowledge of word *use*. Each area is further subdivided into several types. First, knowledge of *form* primarily embraces knowing the written form (how a word looks like), the spoken or phonological form (how a word sounds like), and word parts (what parts are required to recognize the meaning). Second, knowledge of *meaning* entails the ability to relate a word from to a particular meaning, or to associate a foreign language word to its equivalent in the native language; concepts and

referents, knowledge of what a concept might involve as items, and what meanings they might refer to; associations indicate what the network of lexical items that a word can be tied to as well as the words that could replace it. Third, knowledge of word *use* has to do with the grammatical functions of a word (the part of speech to which a word belongs), collocations (what words or types of words that possibly co-occur with a particular one), and constraints on use (the degree of formality and connotation, and the frequency of occurrence of a word in the language).

Additionally, Nation (2000) dichotomised knowledge of word form, meaning and use into two fundamental and mutually exclusive dimensions: receptive knowledge and productive knowledge. On the one hand, receptive or passive word knowledge is applied to words whose meaning can be recognised when heard or read. On the other hand, productive or active vocabulary knowledge refers to words that can be recalled and used in speech or writing. An illustrative example provided by Nation (2000, pp. 40-42) is the word *underdeveloped* to reflect how the notion of receptive-productive knowledge might be applied to a word. To begin with, knowing how the word *underdeveloped* is used receptively comprises a list of aspect:

> (1) being able to recognize the word when it is heard, (2) being familiar with its written form so that it is recognized when it is met in reading, (3) recognizing that it is made up of the parts under-, -develop-, -ed and being able to relate these parts to its meaning, (4) knowing what the word means in the particular context in which it has just occurred, (5) knowing the concept behind the word which will allow understanding in a variety of contexts, (6), knowing that there are related words like overdeveloped, backward and challenged, (7) being able to recognize that words such as territories, areas are typical collocations, (8) knowing that underdeveloped is not an uncommon word and is not a pejorative word.

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Conversely, if the word *underdeveloped* is to be used productively, a number of aspects are considered; these include:

> (1) being able to say it with correct pronunciation including stress, (2) being able to write it with correct spelling, (3) being able to construct it with using the right word parts in their appropriate forms, (4) being able to produce the word to express the meaning "underdeveloped", (5) being able to produce the word in different contexts to express the range of meanings of "underdeveloped", (6) being able to produce synonyms and opposites for <u>underdeveloped,</u> (7) being able to use the word correctly in an original sentence, (8) being able to produce words that commonly occur with it, (9) being able to decide to use or not use the word to suit the degree of formality of the situation (At present <u>developing</u> is more acceptable than <u>underdeveloped</u> which carries a slightly negative meaning).

Above all, Schmitt (2000) estimated that an individual's receptive vocabulary is larger than productive vocabulary. Besides, the growth of receptive word knowledge precedes that of productive word knowledge. However, the gap between the two notions varies from one speaker to another. Nation (1990, 2001) designed the following table that depicts what is involved in knowing a word receptively and productively:

Table 3.2. What Is Involved in Knowing a Word (Nation, 2001, p. 27)

Form	Spoken	R	What does the word sound like?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written or spelled?
	Word Parts	R	What parts are recognisable in this word?
		P	What word parts are needed to express meaning?
Meaning	Form and Meaning	R	What meaning does this word form signal?
		P	What word form can be used to express this meaning?
	Concepts and Referents	R	What is included in the concept?
		P	What items can the concept refer to?
	Associations	R	What other words does this word make us think of?
		P	What other words could we use instead of this one?
Use	Grammatical functions	R	In what patterns does the word occur?
		P	In what patterns must we use this word?
	Collocations	R	What words or types of words occur with this one?
		P	What words or types of words must we use with this one?
	Constraints on use	R	Where, when and how often would we meet this word?
		P	Where, when and how often can we use this word?

Note. R = receptive**; P** = productive

3.2.2. Vocabulary Size

Vocabulary size is widely accepted as a key aspect to consider in research on vocabulary learning, teaching and assessment. Schmitt (2000, p. 2-3) depicted common estimates of the size of the English language with a very wide range: "from (400,000 to 600,000) words (Claiborne, 1983, p. 5), from a half million to over 2 million (Crystal, 1988, p. 32), about 1 million, and 200,000 words in common use although adding technical and scientific terms would stretch the total into the millions The fluctuation in the given records is justified by the issue of what to consider as a word to be a counting unit. As a result, a common attempt to provide a fairly accurate estimate was by choosing word families instead of words as a counting unit. (Goulden, Nation & Read, 1990). Recent studies have shown that a vocabulary size of an adult educated native speaker of English is around 20,000 word families (Schmitt, 2000; Nation, 2000). Other studies have also concluded that young native speakers of English expand their vocabulary repertoires by adding around 1,000 word families a year from the age of two or three. This implies that a five year native speaker beginning school would have a vocabulary size of about 4,000 to 5,000 word families (Waring & Nation, 1997; Nation, 2000).

Nation (2006) supposed that research on the amount of vocabulary required for receptive use reveals that learners require about 6,000 word families to read novels written for teenagers, to watch movies, and to take part in friendly-conversations. Around 8,000 to 9,000 words are required to read newspapers, novels and some academic texts. Read (2000, p. 82) pointed out that estimating an individual's vocabulary size is one facet of research into vocabulary knowledge development at different ages and its role in reading comprehension. Likewise, Nation (2006) considered that vocabulary size measurement is crucial for planning, diagnosis and research. Moreover, testing vocabulary size can be a significant contributor to

research on language proficiency as well as the outcomes of experimental enquiries on language learning.

3.2.3. Word Frequency

Schmitt (2010) emphasized that the frequency in which words occur in a language (in both spoken and written discourse) is envisaged as one of the most fundamental aspects of lexical knowledge as far as it impacts the acquisition, processing and use of vocabulary . Ciarlo and Giannoni (2012) indicated that it plays a key role in both receptive and productive lexical knowledge, and that the more the frequent the word in the language is, the faster and easier it will be acquired and remembered. By the same token, lexical research suggested that it is convenient to divide vocabulary into three main levels. (Nation, 2006) classified them into: high-frequency vocabulary of about 2,000 words, a mid-frequency vocabulary of an additional 7,000 words leading to a total of 9,000, and the remaining is a low-frequency vocabulary of at least 10,000 words but probably higher.

Nation (2000) indicated that high-frequency words are usually short, comprising few syllables and whose meaning is less likely to be restrained like words with lower frequency. On the other hand, lower frequency words are those which do not occur very often in the language (rarely encountered and have less semantic relations with other words); they mainly embrace: proper nouns, technical words specific to particular subject areas and make up about (5%) of an academic text. Ellis (2002, p. 152, In Schmitt, 2010, p. 63) summarized that,

> for written language, high-frequency words are named more
> rapidly than low frequency ones ... , they are more rapidly
> judged to be words in lexical decisions tasks..., and they are
> spelled more accurately ... Auditory word recognition is better
> for high-frequency than low frequency words ... there are
> strong effects of word frequency on the speed and accuracy of
> lexical recognition processes (speech perception, reading,
> object naming, and sign perception) and lexical production

processes (speaking, typing,writing, and signing), in children
and adults as well as in L1 and L2.

3.3. Lexical Processing and Learning

Research into vocabulary growth and development continually attempts to explore the exact way in which words are stored and linked in the mind, and how they are accessed in both native-speakers and foreign language learners (FLL). Such an issue is conceived as a complex process that involves creating and regularly enlarging vastly complex word-networks with recurrent exposure to the language. In the same vein, it recruits a number of strategies deployed to acquire and retrieve words whenever needed for practical use. Schmitt (2010) speculated that vocabulary learning is incremental in nature. That is, mastering all aspects of lexical knowledge is gradual and requires multiple exposures. Some aspects are assumed to be learned before others. For example, word spoken and written forms need less exposure to language input and are usually learned first compared to meaning and grammatical behaviour; whereas such aspects as frequency, register constrains, and collocation relatively require repeated exposure and hence learned at a later time.

3.3.1. The Mental Lexicon

The mental lexicon is a concept used in linguistic and psycholinguistic studies to refer to an individual's store of words and their features: morphological, phonological, syntactic and semantic (Jarema & Libben, 2007). Numerous studies have offered valuable insights that contributed to the understanding of the architecture and functioning of the mental lexicon. The central issues addressed in such an area concern the way in which lexical items are organized and connected with each other, how it may be expanded, and the differences between L1 and L2 mental lexicons. McCarthy (1999, p. 34) suggested some metaphors that try to capture the essence of organization in the mental lexicon; these include: a mental dictionary, thesaurus, encyclopedia, library and computer. All such metaphors share in

common the idea of input, storage and retrieval of lexical representations. Accordingly, the mental lexicon entails a critical process of creating links between lexical items to be arranged and stored in associative network or word-webs. Sorts of linkage account for semantic (meaning), morphological (form), phonological (sound) and associations. What is more, McCarthy (1999, p. 34) postulated that "the mental lexical is never a static in nature. It is constantly receiving new input which to be integrated into the existing store." (p. 34). Additionally,Albrechtsen, Haastrup and Henriksen (2008)claimed that labyrinthine connections between words in lexical networks go stronger or weaker over time; they are affected by factors such as aging, the frequency of using certain lexical items, and re-adjusting the connections by creating new links.

3.3.2. Lexical Competence

Differences in lexical competence across speakers of a language are recognised as being an important issue in vocabulary research. Broadly speaking, lexical competence has to do with one's ability to understand and use lexical items in a diversity of contexts. Albrechtsen et al. (2008) hypothesized that vocabulary depth (size of the lexical repertoire) and breadth (quality of lexical knowledge) are two primordial dimensions of the construct with taking into account the level of frequency of words. Moreover, they stated that "A large vocabulary with knowledge of lexical items across a range of frequency bands has been seen as a hallmark of good lexical knowledge; that is, lexical competence has primarily been defined as the number of words in the lexicon." (p. 26). Another hypothesis was formulated by Henriksen (1999) that viewed lexical items as a three-dimensional construct that involves: partial to precise word meaning, depth of knowledge, and receptive and productive mastery. Each dimension is dependent and believably impacts the development of the other dimensions. Equally important, lexical networks become denser as competence develops.

3.3.3. Vocabulary and Memory

It goes without saying that vocabulary heavily depends on memory functioning. The major process of memory; namely, encoding, storage, rehearsal and retrieval are constantly required to acquire and use lexical items. It is worth remembering that extending vocabulary knowledge, in both L1 and L2, is incremental in nature (words cannot be learned in a linear order nor can they be learned from a single exposure), and that a certain portion of lexical knowledge is unavoidably subjected to forgetting or attrition. Schmitt (2000) touched on two basic types of memory conceptualized in psychological research that play a crucial role in learning vocabulary: the short-term memory (also referred to as working memory), and the long-term memory. On the one hand, the short-term memory is conceived as a brief capacity-limited store of information that is affected by distractions and interruptions. On the other hand, long-term memory is believed to be a permanent store of information whose capacity is unlimited. In terms of vocabulary learning, the goal is to manipulate lexical information in short-term memory to be transferred to long-term memory. To do so, an individual is required to find pre-existing information in the long-term memory to link the new information leading to an expansion of the mental lexicon. In other words, recall and retention of words information are dependent on the functioning of both memory types.

Carter (1998) supposed a number of ways adhering to memory functioning that largely contribute to the growth of vocabulary knowledge; these include, repetition (rehearsal), rote learning, translation of L1 words into their L2 counterparts, and the keyword technique (associating words of different languages that sound alike, and creating mental images of keywords). He assumed that "the clear principle which emerges is that the more words are analyzed or are enriched by imaginistic and other associations, the more likely it is that they will be retained." (p. 195). Such techniques allow for the combination of word's form, meaning and use: the central constituents of receptive and productive lexical knowledge.

Nevertheless, words are always subjected to attrition (forgetting). Schmitt (2010) claimed that "lexical knowledge seems to be more prone to attrition than other linguistic aspects, such as phonology or grammar. This is logical because vocabulary is made up of individual units rather than a series of rules." (p. 23). He argued that forgetting is a natural consequence that would arise even if a word is well known. For example, an individual learning an L2 would forget words if s/he does not use them for a long time, or as s/he gives up a course of study.

3.3.4. Vocabulary Learning Strategies

3.3.4.1. Conceptions of Learning Strategies

Learning is an endless process of acquiring new knowledge; it involves a set of strategies that allows the attainment of a learning objective. The learning strategies refer to "the special thoughts or behaviors that individuals use to help them comprehend, learn, or retain new information." (O'Malley & Chamot, 1990, p. 1). In language education research, Shmitt (2010) speculated that interest in the study of language learning strategies began to grow by the 1970s; it was stimulated by a shift of focus from teaching-oriented perspective to a one that concentrates on how learners' behaviours would influence their language acquisition. Cohn (2011) defined language learning strategies regarding them as "thoughts and actions, consciously chosen and operationalized by language learners, to assist them in carrying out a multiplicity of tasks from the very outset of learning to the most advanced levels of target language performance." (p. 136). Accordingly, regarding the importance of vocabulary in language learning, vocabulary learning strategies are envisaged as an integral sub-category of general language learning strategies. Studies have shown that learners employ a wide variety of strategies to expand their vocabulary knowledge; however, they differ from an individual to another in terms of their types and the number of aspects of lexical knowledge they target. Nation (2000) insisted that "no matter how much a learner knows,

there will still be words that are unknown and strategy use provides a way of coping with these unknown words." (p. 359).

3.3.4.2. Taxonomies of Vocabulary Learning Strategies

Nation (2000, pp. 353-358) designed a working taxonomy of the most frequently used vocabulary learning strategies. It is divided into four major divisions that include

1. Planning: strategies that fall under this category concern where, how, and how often a learner focuses attention to lexical item. Typical examples of this sort of strategies include:

- choosing words,

- choosing the aspects of word knowledge,

- choosing strategies,

- planning repetition .

2. Finding information about words (sources): a class of strategies that has to do with a learner's ability to deal with unfamiliar or newly encountered words. To do so,   a learner is assumed to rely on the word form itself, the context in which it is encountered, a reference source or linking it to translational equivalents in other languages. Some examples of this type may involve:

- analysing the word,

- guessing from context,

- consulting a reference source in L1 or L2,

- using parallels in L1 and L2.

3. Establishing word knowledge (processes): a battery of strategies based on the techniques that learners employ to facilitate the retention and making words stored in the mental lexicon accessible; some characteristic examples of such strategies in this vein incorporate:

- noticing,

- retrieving,

- generating.

Schmitt (2010) argued that the conceptualization of vocabulary learning strategies employed by both L1 and L2 learners is still surrounded by controversy. A major source of confusion is related to the defining criteria for language learning strategies: whether they ought to be considered as observable behaviours or inner mental operations or both. Another issue arises from the large diversity of the techniques used by learners to make a vocabulary learning activity fruitful, which depends on each individual's own learning style or preference. On top of this, the measurement of vocabulary learning strategies also remains a problematic matter; specifically, the accuracy of the assessment of the strategies that depend on mental processing may not possibly be highly precise.

3.4. Vocabulary Teaching

Repeatedly, it was until the 1980s that the area of vocabulary gained interest in language research. For a long time, considerable attention was accorded to grammar and phonology, while vocabulary has been given a lower status.

3.4.1. The Lexical Approach

The field of language teaching has undergone major trends: from the traditional grammar-translation method, to audiolingualism, to the recent communicative approaches. Each language teaching methodology is based on particular assumptions and theories regarding the nature of the learning process. In the early 1990s, the lexical approach was recognised as a conventional method of foreign language teaching that assumes a central role for vocabulary in language structure, L2 learning, language use and multiword units (lexical chunks) that are used as single lexical units. Richards and Rodgers (2001) emphasized that

> A lexical approach in language teaching refers to one derived
> from the belief that the building blocks of language learning and
> communication are not grammar, functions, notions, or some

other unit of planning and teaching but lexis, that is, words and word combinations. (p. 131)

With that said, lexical approaches aim at developing proposals for curriculum designs and instructional procedures that cater for the needs of language learners to acquire adequate vocabulary knowledge as a primary objective.

3.4.2. Formal Vocabulary Instruction

In view of what has been discussed earlier, vocabulary knowledge is a multi-dimensional construct that involves a number of aspects (form, meaning, use, collocations, register); therefore, instructional procedures to teach vocabulary ought to touch on as many aspects as possible. There are a number of vocabulary sources including books, dictionaries, corpora, media that a learner can benefit from, but explicit classroom instruction remains a prerequisite to vocabulary enrichment. Teachers have at their disposal a wide selection of vocabulary teaching strategies with varying notions and learning goals. Thornbury (2002, pp. 75-76) indicated that a teacher should take into account a number of criteria when selecting lexical items to teach. They basically incorporate:

> the level of the learners (whether beginners, intermediate or advanced); the learners likely familiarity with the words (learners may have met the words before even though they are not part of their active vocabulary); the difficulty of the items—whether, for example, they express abstract rather than concrete meanings, or whether they are difficult to pronounce; their 'teachability'—whether, for example, they can easily be explained or demonstrated; whether items are being learned for production […] or for recognition only. Since more time will be needed for the former, the number of items is likely to be fewer than if the aim is only recognition.

3.4.2.1. Conditions to Attain Vocabulary Learning Goals via Instructions

Nation (2000) suggested that a teacher should lead learners through three major processes that increase the chances that a newly presented vocabulary item is fully learned; these include noticing, retrieval and creative (generative) use.

Firstly, *noticing* has to do with devoting adequate attention to vocabulary item. Noticing may be influenced by the importance of the word in a text, learners' prior knowledge about the word, and learners' belief that a newly encountered word adds to their language knowledge. Noticing takes place when learners search a word in dictionary, intentionally analyse a word, guess from context, seek an explanation of the word. Moreover, noticing entails decontextualization of items. That is, dealing the word out of context while listening or reading, by highlighting a word while by way of writing it on the board, negotiating the meaning of the word with peers and the teacher, and explaining a word by giving a definition, a synonym, or a translational equivalent.

Secondly, *retrieval* is another process that refers to the ability of the learner to recall a word after it has been learned to cope with a language learning task. Retrieval is divided into receptive and productive. Nation (2000, p. 103) Receptive retrieval means "perceiving the form and having to retrieve its meaning when the word is met in listening or reading." On the other hand, productive retrieval refers to "wishing to communicate the meaning of the word and having to retrieve its spoken or written form as in speaking or writing." Furthermore, Baddeley (1990) stressed that retrieval is mostly promoted through repetition and having repeated opportunities to retrieve a word. By doing so, the form-meaning connection of a word is reinforced, and hence a later retrieval is easier.

Thirdly, the *generative (or creative) use* of words maximizes vocabulary retention. Nation (2000) clarified the process stating that it "occurs when previously met words are subsequently met or used in ways that differ from the previous meeting with the word. At its

most striking, the new meeting with the word forces learners to reconceptualize their knowledge of that word." (p. 105).Therefore, a teacher is required to diversify the context in which target words may be recurrently used by learners to attain a full mastery of the word.

3.4.2.2. Common Vocabulary Teaching Strategies

3.4.2.2.1. Translation

Translation has long been a feature of many language classroom activities and a facilitator of learning. In L2 vocabulary teaching, it is considered as the most direct way to words meanings. Gairns and Redman (1986) acknowledged that "translation can be a very effective way of conveying meaning. It can save valuable time that might otherwise be spent on a tortuous and largely unsuccessful explanation." (p. 75). Accordingly, translation might be efficacious in teaching low-frequency words whose meaning is highly likely to be difficult to grasp by a large portion of learners. However, translation has its drawbacks; Thornbury (2002) argued that "an over-reliance on translation may mean that learners fail to develop an independent L2 lexicon, […] also learners don't have to work very hard to access the meaning, it may mean that the word is less memorable." (p. 77). Thus, despite the advantages that translation may offer in L2 classrooms, it ought to be used with moderation.

3.4.2.2.2. Visual Techniques

A number of visual aids may be used as devices of presenting vocabulary. They include flashcards, charts, maps, pictures, blackboard drawings, realia (objects such as fruits), mime and gesture, which all appeal to the learners' perception. Gairns and Redman (1986, p. 73) explained that visual means " are extensively used for conveying meaning and are particularly useful for teaching concrete items of vocabulary." Such a sort of instructional practices seem to be easily handled and reasonably designed for learners at beginning levels.

3.4.2.2.3. Verbal Techniques

One more type of vocabulary instruction procedures is depending on verbal material to demonstrate lexical items. According to McCarthy (2010), using verbal material to convey meaning is most useful when the target words refer to abstract concepts. A wide variety of verbal techniques may incorporate: diversifying the contexts, in which a target word might occur, providing words that are semantically related with the target word such as synonyms and antonyms, providing adequate definitions of words, giving contextualized examples that clearly illustrate the meaning of a word. Further, such techniques help making the meaning of newly introduced words, more or less, easier to grasp. Nonetheless, the active involvement of learners in vocabulary learning tasks consistently remains a necessity.

3.4.2.2.4. Vocabulary Teaching Strategies Targeting Aspects of Word Knowledge

Nation (2000, pp. 136-138) made a classification of a battery of vocabulary teaching strategies, each of which is designed to enhance the mastery of a particular aspect of lexical knowledge. It is demonstrated in the following table:

Table 3.3. A Classification of Vocabulary Teaching Activities Based on Aspects of Word Knowledge (Nation, 2000, pp. 136-138)

Form	Spoken form	Pronounce the words
		Read aloud
	Written form	Word and sentence dictation
		Finding spelling rules
	Word parts	Filling word parts tables
		Cutting up complex words
		Building complex words
		Choosing a correct form
Meaning	**Form-meaning connection**	Matching words and definitions
		Discussing the meanings of phrases
		Drawing and labelling pictures
		Peer teaching
		Riddles
	Concept and referent	Finding common meanings
		Choosing the right meaning
		Semantic feature analysis
		Answering questions
		Word detectives
	Associations	Finding substitutes
		Explaining connections
		Making word maps
		Classifying words
		Finding opposites
		Suggesting causes or effects
		Suggesting associations
		Finding examples
Use	**Grammar**	Matching sentence halves

		Putting words in order to make sentences
	Collocates	Matching collocates Finding collocates
	Constraints on use	Identifying constraints Classifying constraints

To sum up, Schmitt (2010, p. 142) believed that "that there is no "right" or "best" way to teach vocabulary. The best practice in any situation will depend on the type of student, the words that are targeted, the school system and curriculum, and many other factors."

3.5. Vocabulary Assessment

Milton (2009) claimed that vocabulary assessment is not different from assessment of other language properties; that is, the criteria of reliability, validity and practicality need to be satisfied when designing a vocabulary test. According to Read (2000), the main objectives of measurement of vocabulary knowledge are: to determine the appropriate level where to place learners in a language teaching programme (placement), to evaluate the learners' progress in vocabulary learning after having pursued a particular course of study (achievement), to determine where learners have gaps in vocabulary knowledge before designing a vocabulary teaching/learning programme or a syllabus (diagnostic), to determine the extent to which learners' vocabulary knowledge allows them to cope with different language learning tasks such as TOEFL tests (proficiency), to deepen understanding of the vocabulary learning process.

In fact, there exist a wide variety of vocabulary tests well recognised in the lexical literature, each of which is designed specifically to assess a focal aspect of word knowledge (form, meaning, use, pronunciation, grammatical behaviour, collocation, register and frequency). They can also be distinguished according to the type of word knowledge they focus on. For example, tests of recognition/recall (receptive knowledge) or production

(productive knowledge). Nation (2000, p. 560) described the defining characteristics of a convenient vocabulary test as follows:

> A good vocabulary test has plenty of items (around 30 is probably a minimum for a reliable test). It uses a test item type which requires learners to use the kind of vocabulary knowledge that you want to test. It is easy enough to make, mark, and interpret, and it has a good effect on the learning and teaching that leads up to the test and that follows it.

3.5.1. The Frequently Used Types of Vocabulary Tests

3.5.1.1. The Yes/No Tests

The Yes/No tests, also known as checklist vocabulary tests, are very popular in vocabulary assessment. According to Nation (2000), the procedure followed in such a sort of tests entails giving learners a list of items to which they respond by saying whether they know the word or not or simply ticking the words they know on the list. Besides, some non-sense words are included to avoid the possibility that learners over-state their lexical knowledge. Important to note, the Yes/No tests were found to correlate high with language proficiency and placement tests.

3.5.1.2. The Multiple-Choice Tests

As the name of the test suggests, learners' knowledge of the lexical items is elicited by giving them a number of choices (also referred to as distracters) to select from. Thornbury (2002) assumed that multiple-choice tests are easy to design and score. Besides, they can be used with isolated words, words in a sentence context, or words in entire texts. Nation (2000, p. 564) argued that multiple-choice vocabulary tests "have a degree of respectability because they are used in standardized tests like TOEFL." Furthermore, it is possible to vary the degree of difficulty in multiple choice-tests by varying the closeness of meaning between choices or the gradation of the level of frequency. The performance of the examinees may

also be informative in regard to the strategies they use to answer; for instance, guessing and inferring from context.

5.5.1.3. The Vocabulary Size Tests

The main purpose of vocabulary size tests is to obtain an estimate of the total size of the learners' vocabulary knowledge in which word families is considered as the counting unit (the total size is estimated as how many word families a learner knows). Schmitt (2000, p. 164) stated that "almost all of the widely used vocabulary tests to date have been of the 'size' variety, returning an estimate of the number of words known from frequency lists or other word samples." Accordingly, in such tests, the lexical knowledge to be assessed is based on the degree of frequency in which words occur in the language, ranging from high-frequency words to low-frequency words. Besides, the items are usually selected from commonly used corpora such as the British National Corpus (BNC). A typical example of a widely used standardized version of this type of tests is the one developed by Nation and Beglar (2007), containing 140 multiple-choice items with ten items from each 1,000 word frequency level in a total of fourteen: 1,000, 2,000, 3,000, 4,000, 5,000, 6,000, 7,000, 8,000, 9,000, 10,000, 11,000, 12,000, 13,000 and 14,000. This means that every word represents 100 word families. The participant's total score (the total number of correct choices) needs to be multiplied by 100 to calculate his/her overall receptive vocabulary size. The test takers are required to select the best definition of each word form out of four choices provided in short contexts. In this case, the performance of the examinees provides information not only how many words they know, but also at what frequency-levels.

5.5.1.6. The Vocabulary Depth Tests

As previously illustrated, the depth of word knowledge refers to how well a learner knows a word (or the quality of knowledge). A widely used format of this test is the gap-fill format which requires learners to retrieve a word from memory store in order to complete a

sentence or text. Thus, it measures the test-takers ability to produce the word rather than recognize it. A characteristic example of this type of test is the Vocabulary Levels Test. Originally, this test was developed by Paul Nation at Victoria University of Wellington in New Zealand in the early 1980s as a simple means to design programmes of vocabulary teaching and learning. Read (2000, p. 118) asserted that "in the absence of any more sophisticated measure, it has been used by researchers who needed an estimate of the vocabulary size of their non-native-speaking subjects." Similarly, Meara (1996, p. 38) referred to it as "the nearest thing we have to a standard test in vocabulary." It was basically used as a frequency-based diagnostic tool to measure written receptive vocabulary knowledge at four frequency levels 2,000, 3,000, 4,000 and 10,000, hence the name of the test. However, it was later revised, republished, and underwent tests of validation (Read, 1988; Schmitt, Schmitt & Clapham, 2001). An alternative version was devised by Laufer and Nation (1999), a revised version, which measures the written productive vocabulary knowledge (depth) at five frequency level ranges. It is called the Productive Vocabulary Levels Test (PVLT). It takes a fill-in-the-gap format test that comprises five sections, each of which representing a frequency level range and considering word families as a counting unit: 2,000 level, 2,000 to 3,000 levels, 3,000 to 5,000 levels, the University Word List (UWL), and the 5,000 to 10,000 levels. The University Word List involves a specialized vocabulary for second language learners to undertake academic study in English. It comprises about 570 word families that do not belong to the 2,000 most frequent words but show up fairly reasonably in diverse academic texts; it is often called *sub-technical vocabulary* and usually involves formal vocabulary (Nation, 2000).

Conclusion

Vocabulary is beyond doubt a paramount component of language comprehension and use. Vocabulary knowledge is a rich and multi-dimensional construct. Thus, acquiring an

adequate lexical knowledge is not only limited to form and meaning but to numerous aspects as well. Another central issue is the multiplicity of the linguistic features of lexical items. Receptive and productive are deemed primordial dimensions of an individual's knowledge of words. Besides, research endeavours conducted psychology, education, applied linguistics and other related disciplines still enquire the process of acquiring and learning vocabulary in L1 and foreign languages; notably, the architecture of one's mental lexicon, the role of memory in expanding vocabulary knowledge, the frequently used vocabulary teaching and learning strategies and what lexical features they specifically target, and designing effective measurement tools to assess different aspects of lexical knowledge.

Chapter Four

Vocabulary Assessment and Working Memory Measurement

Introduction

The present study aims essentially to explore the relationship between the working memory capacity and lexical competence among Master 1 EFL students. Evidently, as reviewed in the literature, attaining a satisfactory level in L2 lexical competence necessitates acquiring an adequate knowledge of multiple aspects. Besides, it recruits a number of cognitive processes and abilities, particularly memory. The WM is a cognitive construct that is assumed to play a central role in academic achievement. Therefore, the aim of the present work is to reveal the implication of individual differences in WM functioning in the process of vocabulary building among students, and the extent to which its capacity (WMC) might determine fluctuations in students' receptive and productive vocabulary knowledge. To satisfy the criteria of reliability, validity and practicality, four widely used tests were administered as basic data collection procedures to fulfill the aforementioned objectives of the study: two tests for vocabulary assessment and two tests for the measurement of WMC, on a one to one basis. First, concerning vocabulary assessment, we administered the Vocabulary Size Test (VST) to assess students abilities to recognise and comprehend lexical items (receptive vocabulary knowledge), then the Productive Vocabulary Levels Test, to assess their abilities to use different lexical items in diverse contexts (productive vocabulary knowledge). Both vocabulary tests assess students' knowledge of words at varying frequency levels. Second, on the subject of WMC measurement, we gave the Reading Span Test (RST), to measure the students' memory capacities to recognise and retain words of varying frequency levels for subsequent recall, then the Speaking Span Test (SST) to measure their memory abilities to retain lexical items and reproduce them in various contexts. Ultimately, two correlational analyses were carried out to determine the strength of the association between the scores by means of Pearson product Correlation Coefficient. On the one hand, a first correlation coefficient (r.) was calculated to estimate the strength of the association between the scores

obtained by subjects in the VST and the RST. On the other hand, a second correlation coefficient was calculated to determine the strength of the association between the scores obtained by the subjects in the PVLT and SST. Eventually, the present study relied primarily on pure quantitative data analyses in hope of obtaining rational and more objective findings.

4.1. The Participants

A randomly chosen sample of 40 Master 1 students of English as a Foreign Language (EFL) enrolled at the Department Letters and English, at the University of Frères Mentouri Constantine 1, took part in the study. Four tests were administered on a one-to-one basis from December to April 2017 during the academic year 2016-2017. Characteristically, the sample consisted of (4) males (10%) and (36) females (90%) from different backgrounds. They were aged between (21) and (24) years (Mean=22.37). The number of years that the subjects have formally been studying English as a foreign language ranged between (11) and (14) years (Mean= 11.38). Besides, the choice of Master students is based on the assumption that they have attained relatively advanced levels of lexical competence and cognitive abilities that allow them to cope with the demands of the four tests employed to carry out the investigation. All subjects took the four tests normally accompanied by the researcher until the end of the experimental tasks. The whole population to which we wish to generalize the findings of the study consists of approximately (300) students.

Table 4.1. Table of Participants

	Mean Age (years)	Gender		Years Stadying English
		Male	Female	
Subjects	22.37	4	36	11.38

4.2. Vocabulary Assessment

4.2.1. Introduction

A constant enrichment of lexical knowledge is a fundamental requirement to achieve an adequate mastery over any language by virtue of the crucial role that an extensive repertoire of words plays in the development of the language learning skills (listening, speaking, reading and writing), as well as the achievement of linguistic and communicative competences. Conventionally, conclusions drawn from lexical research have revealed that vocabulary development is complex in nature, and that knowing a word is multifaceted and embraces a number of aspects including form, meaning, use, grammatical properties, collocation, frequency level, register and style. In addition, it is divided into two basic dimensions: receptive and productive knowledge. As a result, a number of assessment paradigms have been distinguished, each of which is concerned with the type of lexical knowledge it targets. From this point, the present research work aims partially to unveil the differences in both receptive and productive frequency-based vocabulary knowledge among EFL university students. To attain such an objective, two standardised tests were administered: the Vocabulary Size Test (VST), to assess the receptive lexical knowledge; and the Productive Vocabulary Levels Test (PVLT), to assess the productive lexical knowledge. Specifically, the tests were given on a one to one basis on print. The scores obtained from performance on these tests are presumed to reveal individual differences in the learners' abilities to recognize comprehend and use words of varying frequency levels of occurrence in the language.

4.2.2. The Vocabulary Size Test

The Vocabulary Size Test (VST) was mainly designed to measure an individual's total receptive vocabulary size in the form of a multiple-choice meaning-recognition format, considering word families as a counting unit. The test basically measures knowledge of written word form, the form-meaning connection, and, to a smaller degree, concept

knowledge (Nation, 2006). It is a corpus-based test that involves multiple sections each of which representing a word frequency level: high-frequency, mid-frequency and low-frequency words. Ciarlo and Giannoni (2012, p. 41) noted that "such a type of test has been extensively used for non-native speakers whose proficiency is limited." In the present study, the 14,000 version, designed by Beglar and Nation (2007), was used. It contains 140 multiple-choice items with ten items from each 1,000 word frequency level in a total of fourteen: (1000), (2000), (3000), (4000), (5000), (6000), (7000), (8000), (9000), (10000), (11000), (12000), (13000) and (14000). This means that every word represents (100) word families (see Appendix 2). The participant's total score (the total number of correct choices) needs to be multiplied by 100 to calculate their overall receptive vocabulary size. The test takers are required to select the best definition of each word form out of four choices provided in short contexts. The time allocated for the test was around (45) minutes session (20 seconds per word) in a classroom with the presence of two invigilating teachers to avoid any bias. Below, we present an example of a word belonging to the 12th (1000) frequency list:

REFECTORY: we met in the **refectory**.
a. room for eating.
b. office where legal papers can be signed.
c. room for several people to sleep in.
d. room with glass walls for growing plants.

Considering the frequency factor, Ciarlo and Giannoni (2012) indicated that it plays a key role in both receptive and productive lexical knowledge, and that the more frequent a word is, the easier it will be acquired. Similarly, lexical research suggested that it is convenient to divide vocabulary into three main levels. (Nation, 2006) classified them into: high-frequency vocabulary of about (2000) words, a mid-frequency vocabulary of an additional (7000) words leading to a total of (9000), and the remaining is a low-frequency vocabulary of at least (10000) words but probably higher. Nation (2000) indicated that high-frequency words are usually short, comprising few syllables and whose meaning is less likely

to be restrained like words with lower frequency. On the other hand, lower frequency words are those which do not occur very often in the language (rarely encountered and have less semantic relations with other words); they mainly embrace: proper nouns, technical words specific to particular subject areas and make up about (5%) of an academic text.

4.2.2.1. Results and Discussion of the VST Scores

<p align="center">**Table 4.2. The Means of VST Answers**</p>

	CA	WA	NA	Total Size
means	63,05	34,85	42,1	6305
SD	17,0444	20,1158	28,5161	1704,436

<p align="center">**Figure 4.1. The Vocabulary Size of Participants**</p>
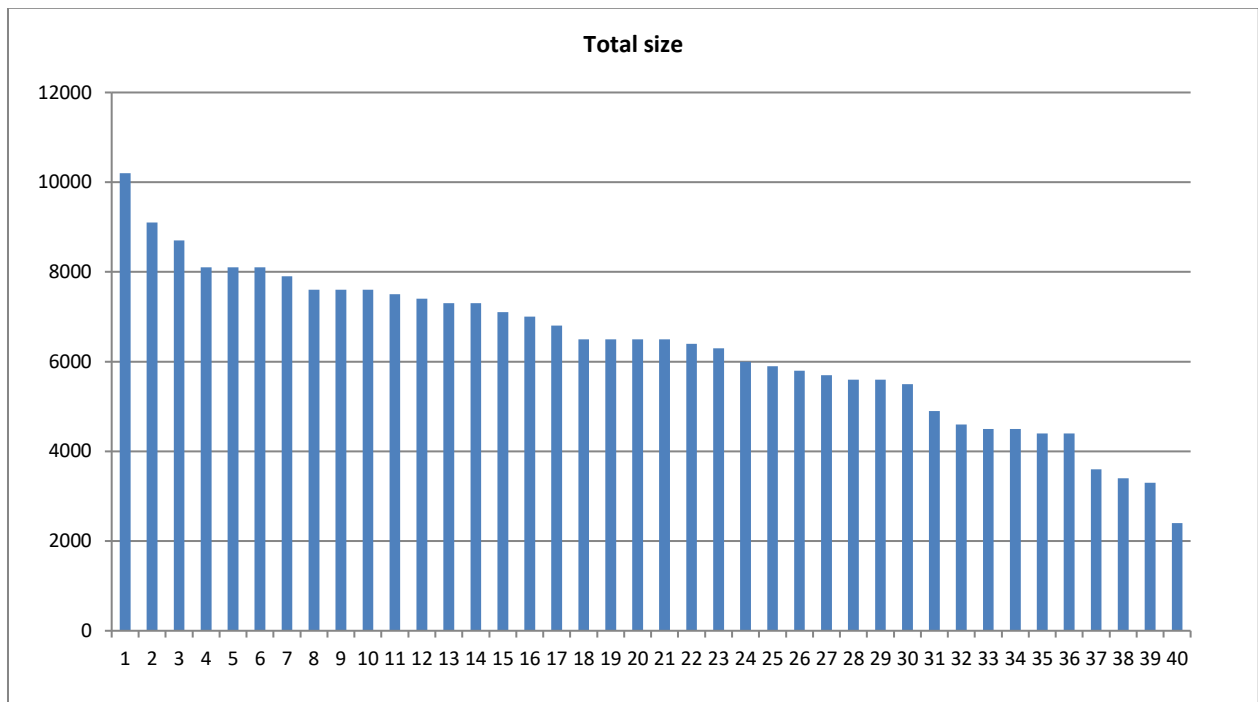
Table (4.2) and figure (4.1) illustrate the means of the total scores obtained by the (40) subjects in the VST; they are divided into columns: column one has to do with correct answers or successful choices (**CA:** Correct answers); column two embraces the wrong answers (**WA:** Wrong Answers); column three represents the entries that remained unanswered (**NA:** No Answer); column four demonstrates the mean vocabulary size

calculated by multiplying the correct answers by (100). The mean in the three first columns is obtained by summing the scores obtained by all of the subjects out of (140) and dividing the total by (40). In column one; the mean of correct answers made is (M=63.05; SD=17.04) out of (140) choices, which might be marked as below the average. In column two, the mean of the wrong answers is (M=34.85); however, this does not exclude the probability of making 'blind guesses'. Finally, in column three, the mean of unanswered entries is (M=42.1; SD=28.51). In column four, after multiplying the number of correct answer by (100), which is the conventional way of obtaining the overall receptive vocabulary size, we obtained the mean size of (6305) word families (SD= 1704.43). The scores of the whole sample are shown in Appendix (4) ranked from highest to lowest.

Table 4.3. The Mean Percentages of VST Scores

	CA%	WA%	NA%
Means (M)	45,03	24,89	30,07
SD	12,1745	14,3684	20,3687

Figure 4.2. The Mean Percentages of VST Scores
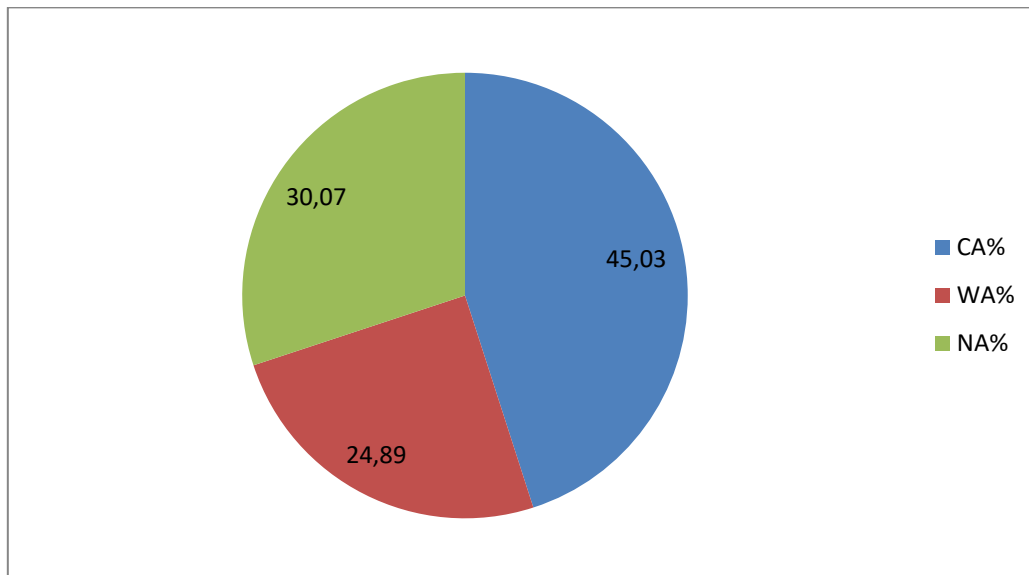
N= 40

SD: Standard Deviation

CA: Correct Answers

WA: Wrong Answers

NA: No Answers

Table (4.3) and figure (4.2) demonstrate the means of percentages of the scores obtained by all subjects in the VST. The mean percentage of the correct answers of all subjects is around (45.03 %; SD= 12.17). The mean percentage of the wrong answers is (24.89%; SD= 14.36). The percentage of the entries remained unanswered is (30.07%; SD= 20.36).

Table 4.4.   The Maximum Frequency Levels Attained by the Subjects Based on Their Total Scores

Word level	2k-3k	3k-4k	4k-5k	5k-6k	6k-7k	7k-8k	8k-9k	9k-1k	10k-11k	12k-14k
N	1	3	6	7	7	10	4	1	1	0
%	2.5 %	7.5 %	15%	17.5 %	17.5 %	25%	10%	2.5 %	2.5%	0%

(**K: kilo** =1000 words; **N:** the number of subjects; **%:** percentage of the subjects)

Table (4.4) shows a division of the maximum word frequency levels attained by the subjects based on the calculation of their total vocabulary size scores. Such a sort of data is assumed to reveal the subjects' ability level to recognise word meanings in restricted contexts. As dictated by the designers of the test Nation and Beglar (2007), the total size of the subject is calculated by multiplying the total number of the correct choices they made by 100, with disregard to the mistaken choices which are interpreted as *'blind guesses'* (Nation, 2000). As it can be noticed, the highest score was (102) (x100) which means that the subject' overall score is (10200) word families. At the other end of the spectrum, the lowest score was (24) (x100) which implies that her total vocabulary size is (2400) word families, which can be

considered as an unexpectedly very low score. The subject has seemingly a deficient lexical knowledge though she has the same academic level and the same number of years spent in studying English. In the middle of the spectrum, the scores start to increase at level (4000)to reach an apex of the level (7000-8000) attained by (25%) of the subjects. Ultimately, the scores start to drop to stand at 10,000 levels as a maximum score, and no subject scored above 12000 levels (0 %). In essence, the maximum average sizes of vocabulary that the participants are assumed able to use receptively ranges between (5000) and (8000) word families which is categorized as a mid-frequency vocabulary.

Table 4.5. The Divisions of Word Frequency Types Attained by the Subjects

Frequency Level	N	%
High Frequency (2000 Words)	1	2.5%
Mid- Frequency (3000-9000 Words)	38	95%
Low- Frequency (10000 Words and more)	1	2.5%

Table (4.5) comprises three main divisions of the word frequency types, categorised by Nation (2000), and according to which the scores of the subjects are classified. The reliance on the frequency factor, as a basic aspect of lexical knowledge, is assumed to provide insights about the fluctuation in the subjects' abilities to cope with various tasks and activities in the TL. The table reveals that only (2.5%) of the subjects did not exceed the high-frequency level (2000), which we view as a remarkably limited lexical repertoire that would inevitably hinder coping with a wide range of activities in the target language. the vast majority of the participants scored between (3000) and (9000) (the scores' climax came between 6000 and 8000 word frequency levels), which is categorised as a mid-frequency vocabulary type. At this level, for receptive language use, according to Nation (2006), an individual might sufficiently engage in activities like reading novels written for teenagers, watching movies,

reading newspapers, and reading some academic texts. Only one subject (2.5%) attained the low-frequency level (10000 word families and on) which is deemed a satisfactorily proficient level that enables the subject to successfully engage in a rich diversity of activities in the target language.

4.2.3. The Productive Vocabulary Levels Test (PVLT)

At first, Vocabulary Levels Test was originally developed by Paul Nation at Victoria University of Wellington in New Zealand in the early 1980s as a simple means to design programmes of vocabulary teaching and learning. Read (2000, p. 118) argued that "in the absence of any more sophisticated measure, it has been used by researchers who needed an estimate of the vocabulary size of their non-native-speaking subjects." Similarly, Meara (1996, p. 38) referred to it as "the nearest thing we have to a standard test in vocabulary." It was basically used as a frequency-based diagnostic tool to measure written receptive vocabulary knowledge at four frequency levels (2000), (3000), (4000) and (10,000), hence the name of the test. However, it was later revised, republished, and underwent tests of validation (Read, 1988; Schmitt, Schmitt & Clapham, 2001). The present study deployed a revised version of the same tool devised by Laufer and Nation (1999), which measures the written productive vocabulary knowledge, at five frequency level ranges. It is called the Productive Vocabulary Levels Test (PVLT). It takes the form of a fill-in-the-gap format test that comprises five sections, each of which representing a frequency level range and considering word families as a counting unit: (2000) level, (2000) to (3000) levels, (3000) to (5000) levels, the University Word List (UWL), and the (5000) to (10000) levels. The University Word List involves a specialised vocabulary for second language learners to undertake academic study in English. It comprises about (570) word families that do not belong to the (2000) most frequent words but show up fairly reasonably in diverse academic texts; it is often called *sub-technical vocabulary* and usually involves formal vocabulary (Nation, 2000).

Each section of the test is made up of eighteen (18) unrelated sentences with missing words within, but with the initial letters provided. The participants are asked to fill in the gaps with the appropriate words. The aforementioned test designers set a threshold for each section that every participant has to exceed to be said to have a full mastery of the word frequency level it represents, an adequate ability to use words productively at different frequency levels in different contexts. Below, is a sample of Section five: 5,000-10,000 frequency levels extracted from the original test manuscript:

1. The baby is wet. Her dia........ needs changing
2. If your lips are sore, try lip sal………, not medicine.
3. Second year university students in the USA are called soph……
4. Her favourite flowers were or……. .
5. Three children were taken hos….....

The time allocated for the test was about (60) minutes (approximately 40 seconds per word) in one session with the presence of two invigilating teachers to avoid any biased data.

4.2.3.1. Results and Discussions of the PVLT Scores

Table 4.6. The Scores of the Subjects Achieved at Each Section of Frequency Levels

word Levels	2k Level	2k-3k	3k-5k	UWL	5k-10k
Means (M)	12.1	10.35	7	9.77	3.42
The Mean Percentages	66.94%	57.5%	38.88%	54.30%	19.02%

Table (4.6) depicts the results of the performance of the subjects on the PVLT intended to assess their abilities to actively and appropriately use lexical items at different frequency levels in diverse contexts (productive lexical knowledge). The table shows the means of the scores of all the (40) subjects at each level of frequency (out of 18 correct answers in each of the five sections). In section one, involving high-frequency words, or the 2000 most frequent word families, the mean of the scores was (M=12.1) out (18) correct answers (66.94% of the correct answers). In section two (2000) to (3000) most

frequent words, the mean of the scores decreased to (M=10.35) out of 18 (57.5% of the total correct answers). In section three, frequency levels ranging between (3000) and (5000) most frequent words, the mean of the scores decreased again to (M=7) out of (18) correct answers (38.88% of the total). In the section of University Word List (UWL) the mean of the scores relatively increased to (M=9.77) out of (18) correct answers (9.77%). This might be justified by the fact that the words on this list are not merely selected according to their frequency in the entire corpus; but, rather, it is a list of a specialized vocabulary, particularly that occurring in academic texts (Nation, 2000). In section five, frequency levels between 5000 and 10000, the mean of the scores dropped to a minimum of (M=3.42) out of (18) correct answers (19.02% of the total). The decrease of the scores at each successive section may be explained by the degree of the frequency represented by the section, for it moves from the higher levels of frequency to the lower ones. As it can be seen, the more the frequent the words on the list were, the higher the scores of the subjects had been achieved. Another key point is that the estimates demonstrated in Table (4.6) revealed that the maximum frequency level of the subjects' abilities to use the words productively ranged between (2000) and (3000) (only high-frequency vocabulary). Finally, their performance remarkably deteriorated at the levels above (3000) and on (mid and high-frequency levels).

Table 4.7. A Subdivision of the PVLT Scores in each Section Based on Answers Accuracy

	2K levels			2K-3K levels			3K-5K levels			UWL			5K-10k levels		
	CA	WA	NA	CA	WA	NA	CA	WA	NA	CA	WA	NA	CA	WA	NA
means	11,95	2,4	3,675	10,425	2,975	4,6	6,975	3,925	7,1	9,725	4,225	4,05	3,375	3,925	10,65
SD	3,42	1,7	2,95	3,97	1,62	3,69	3,27	2,36	3,41	3,5	2,1	2,98	2,84	2,65	4,04

Figure 4.3 The Scores of The PVLT Based on Answers Accuracy
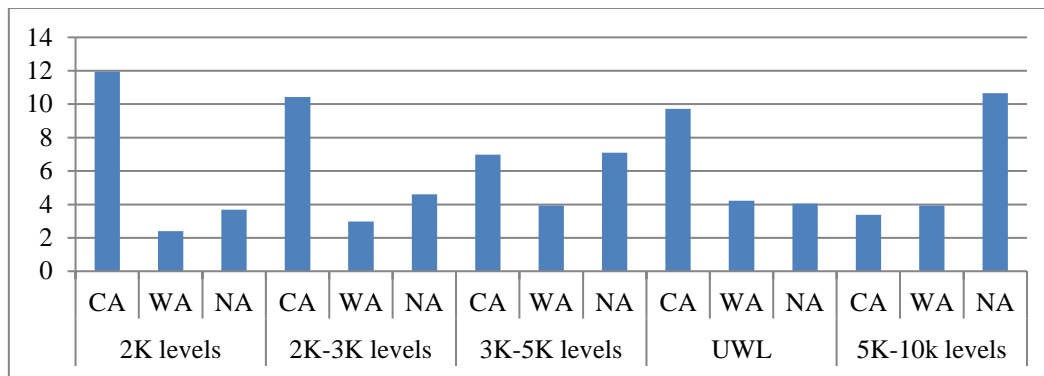
K: Kilo=1000.

UWL: University World List.

CA: Correct Answers.

WA: Wrong Answers.

NA: No Answers.

Table (4.7) and figure (4.3) demonstrate the means of the scores obtained by the subjects at the five word frequency levels involved in the test further classified according to their accuracy: CA, WA, and NA.

Table 4.8. Subjects Scoring Above/Below Levels Thresholds

Levels / Thresholds		2000 Levels	2000-3000	3000-5000	UWL	5000-10000
Threshold		83%	83%	83%	83%	80%
Above threshold	N	11	5	0	2	0
	%	27.5	12.5	0	5	0
Below threshold	N	29	35	40	38	40
	%	72.5	87.5	100	95	100

Table (4.8) dichotomises the scores obtained by of the subjects in each section according to the threshold set by the test instructions (Laufer & Nation, 1999) to determine whether the subject has successfully passed the test and is having an adequate productive lexical mastery over the represented level. In Section One (2000 level), (27.5 %) of the

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sample (11 among 40 of the subjects) scored above the threshold, while (72.5%) scored below. In section two, from (3000-5000) frequency levels, (12.5%) of the subjects exceeded the threshold, whereas (87.5 %) of the subjects scored below. In Section Three (3000 to 5000 levels), none of the participants crossed the threshold. In the UWL section, only (5%) of the subjects crossed the threshold, while a quasi majority (95%) of the subjects did not reach the determined value to pass. Similarly, none of the participants crossed the threshold of section five (5000 to 10000 levels). Given these numbers, the productive lexical knowledge of the participants is markedly meager. The thresholds of only two sections (high frequency word lists) are crossed with very low percentages, while they totally failed in the three remaining sections as the percentages at section three and five come to naught. Note worthily, the scores of the subjects were ranked from the highest to the lowest in both tests, a slight fluctuation in the performance was noticed: some subjects did well in the VST but worse in the PVLT, while the opposite happened to others.

Conclusion

The findings obtained from the subjects' vocabulary assessment were assumed to offer some insights about the subjects' (Master One EFL students) strengths and weaknesses in receptive and productive lexical knowledge, which are considered as two primordial dimensions of vocabulary knowledge and play a substantial role in lexical competence. The performance of the subjects on the two vocabulary tests provided useful descriptive and diagnostic information. The assessment of the subjects' receptive vocabulary knowledge— their ability to recognise and comprehend words at different frequency levels— their performance in the VST—revealed that the ultimate vocabulary sizes of the majority of the participants ranged between 5000 and 8000 word families, which belong to the mid-frequency vocabulary, a level that enables an individual to cope with such activities as reading novels written for teenagers, to watch movies and to take part in friendly conversations. Only one

exception (2.5%) attained the highest size of (10200) word families, and one (2.5%) did not exceed a size of (2400). On the other hand, the data collected from the PVLT, that purports to measure the participants' productive lexical knowledge, or their abilities to use words adequately enough at different frequency levels, revealed that their productive mastery of vocabulary is comparatively lower. Important to realize, the best levels of their lexical productive mastery is (3000) word families (only high-frequency vocabulary), then it sharply decreased at the successive levels which, strictly speaking, were considered as a poor knowledge.

In the final analysis, the participants' abilities to perceive the form of a word and retrieving its meaning, albeit with no full compatibility, are higher than their abilities to express a meaning and retrieve the appropriate form in diverse contexts. Equally important, a meticulous attention should be devoted to aid the learners to attain better lexical proficiency levels, and hence better academic achievement.

4.3. The Working Memory Capacity Measurement

4.3.1. Introduction

As reviewed in the literature, the WM plays a crucial role in academic achievement, particularly in language comprehension and production. Therefore, individual differences in WMC, in terms of storage, processing, manipulating information, focusing attention on a given task, multi-tasking and resisting distractions are key functions that are believed to be a useful predictor of variation in the abilities to comprehend and use language. In this respect, the present study deploys two widely used measurement tools in a computerized format to reveal how variation in the subjects' performance on WMC tasks could be attributed to their abilities to process and store verbal information; precisely, their abilities to comprehend and use vocabulary items. Both tests are classified in memory research as complex span tasks designed for measuring WMC. The first test, the Reading Span Test (RST), is a task that

requires the comprehension and recall of a number of words given in moderately complex sentences. The scores obtained from such a test are supposed to determine the WMC of an individual in regard to language comprehension. The second test, the Speaking Span Test (SST), is another WMC measurement task where subjects are asked to read and recall a number of unrelated words then to put them in semantically and grammatically accurate sentences. The scores obtained from this test are expected to measure one's WMC in the matter of language production. The words used in both tests are selected according their levels of frequency of occurrence in the language classified by the British National Corpus (BNC), and which is considered as a central aspect of a person's word knowledge. The tests were taken by the same sample (40 participants) of Master 1 EFL students that took the previous vocabulary tests on two sequential phased sessions. Each subject took the test individually in front of a computer screen. Besides, the amount of time spent by each individual in performing on the task was measured and recorded by means of a chronograph.

4.3.2. The Reading Span Test

The Reading Span Test is widely used as a WMC measurement tool recognised in cognitive psychological literature. It was first developed by Daneman and Carpenter in 1980. The aim of this test is to measure an individual's ability to recognize and recall words (receptive verbal knowledge). The procedure followed in this test is that every subject out of the 40 participants in the sample is presented with sets of sentences of moderate length and complexity demonstrated on a computer screen. The demonstration incorporates a total of (60) sentences divided into three sections (20 sentences in each). Each section is further divided into blocks of (2), (3), (4), (5), (6) sentences respectively, separated by blank pages. The test-taker is required to read aloud and consecutively the sentences demonstrated on the screen until the blank page shows up. Afterwards, s/he is expected to comprehend and recall the last word in each sentence (see Appendix 11). The total number of recalled words in each

section is recorded by the researcher on a scoring sheet to later calculate the subject's reading span (see Appendix 13). To determine the span, we divide the number of the recalled words by the number of sentences (…/20) in the section. For example, if a participant could recall (13) words out of the (20), we consider that his or her reading span is (0.65). The words to be recalled are selected according to their lexical frequency level determined by the British National Corpus (BNC), with a gradual increase in the frequency level in each following sentence. The words are put in example sentences selected from Oxford Dictionary (2005).

For example, in section one, the first block comprising two sentences appears are as follows

"America is a land of freedom and opportunity."

"In the movie, they take journey backwards through time."

Hereby, the words that the subject is expected to recall, whenever a blank page is shown, are **"*opportunit*y"** and **"*time*"**. Then the number of sentences in the following blocks increases to 3, 4, 5 and 6 sentences respectively until we reach the end of the section. After giving a clear instruction about the task, each subject has performed on the test individually in a quiet empty classroom with the researcher in front of a computer screen, and the time spent by each one during the testing session is recorded by means of a chronograph.

4.3.2.1. Results and Discussions of the RST Scores

Table 4.9. The Means of the Scores obtained in the RST

	Section 1	Section 2	Section 3	Total	Timing (min.)
Means (M)	13,5680871	13,167718	13,2776328	39,9883241	11,2238679
SD	2,81878093	2,92566869	3,01209669	8,15070924	2,34726027

Table (4.9) delineates the means of the scores obtained by the (40) subjects in each section of the RST. The score obtained by every subject is determined by the total number of

the words s/he could recall successfully, while the means are calculated by summing all the scores in all sections and dividing the total by 40. In section (1), the highest score obtained was (18) words out of (20), while the lowest score was (10) out of (20) words (M= 13.56; SD= 2.81). In section (2), the highest score recorded was (20) out of (20), whereas the lowest score was (9) out of (20) (M= 13.16; SD= 2.92). In section (3), the highest score was at (19) out of (20), while the lowest score stood at (10) out of (20) (Mean= 13.27; SD= 3.01). The total score (out of 60 words) is the sum of the scores in the three sections. The highest score found was (53) out of (60), and the lowest score was (29) out of (60) (Mean= 39.98; SD= 8.15). Concerning timing, the longest session lasted 14 minutes while the shortest ended in (8) minutes (M= 11.22 min.; SD=2.34). (See Appendix 14).

Table 4.10. The Means of the Reading Spans

	Span 1	Span 2	Span 3	Total span
Means (M)	0,69875	0,68625	0,69	0,69166667
SD	0,10221113	0,12402827	0,12362059	0,10113318

Figure 4.4. The Means of The Reading Spans
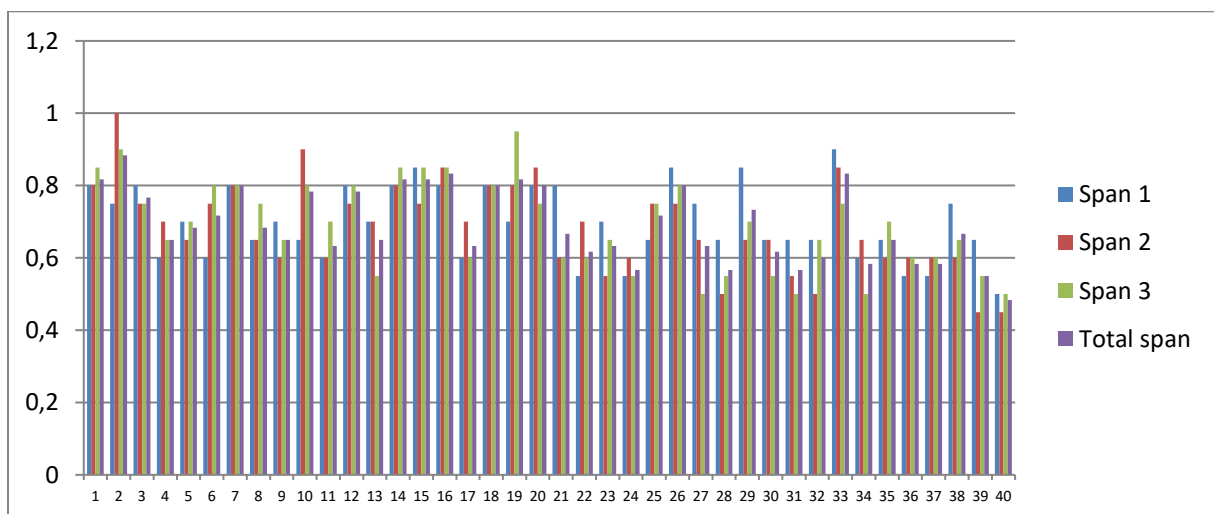
Table (4.10) and figure (4.4) lay out the means of the reading spans achieved by the whole sample. As previously illustrated, the reading span of each subject is calculated by summing the number of the words recalled and dividing the sum by (20) (the total number of words demonstrated in each section). The means of the spans, on the other hand, is obtained by dividing the sum of the spans of all participants in each set by (40). In section (1), the highest reading span recorded was (0.85), while the lowest span was (0.5) (M=0.69; SD=0.10). In section (2), the highest span reported was (1), while the lowest span was (0.45) (Mean=0.68; SD=0.12). In section (3), the highest span attained was (0.95), whereas the lowest span was (0.5) (Mean=0.69; SD= 0.12). the total span is obtained by summing all the spans in the three sections. The highest total span was (0.88), and the lowest span stood at (0.48) (Mean=0.69; SD=0.10). (Appendix 15).

Table 4.11. The Mean Percentages of RST Scores

	Set 1	Set 2	Set 3	Total
Means (M)	67,8404355	65,8385899	66,3881638	66,6472068
SD	14,0939047	14,6283435	15,0604835	13,5845154

Table (4.11) shows the percentages of the scores obtained by 40 subjects in their performance on the RTS of WMC. The score of every subject is interpreted into a percentage in each section by way of further revealing the variance in their performance on the task. The mean percentage is the result of dividing the sum of all percentages by (40). In section (1), the highest percentage of the recalled words was (85%), whereas the lowest percentage was (50%) (M= 67.84; SD=14.09). In section (2), the highest percentage noticed was (100%) (20 out 20 words successfully recalled), while the lowest percentage was (45%) (M=65.83; SD= 14.62). In section (3), the highest percentage attained was (90%), whereas the lowest percentage decreased to (50%) (M=66.38; SD=15.06). Consistently, the percentage of the total scores is the sum of all mean percentages in the three sections. The highest total

percentage reached 88.33%, whereas the lowest stood at 48.33% (Mean=66.64; SD=13.58). (See Appendix 16)

As can be noticed, the above illustrations show a remarkable fluctuation in the performance of the (40) subjects on the RST. Such a WMC measurement tool seems to unveil significant differences in the individual abilities to comprehend sentences and recall words involved in. So to speak, the ability of learners to process and store vocabulary, which is a central function attributed to the WM operating systems, significantly differs from one learner to another. Additionally, through the administration of the test, a number of factors seemed to influence the subjects performance; these include, the frequency of words (the high frequency words were easier to comprehend and recall compared to low frequency words), the length of words (the pace of reading slowed down at longer words which are assumed to require more processing), distractions (noise and unexpected interruptions; for example, someone opening the door of the classroom), and frustration (some students seemed anxious).

4.3.3. The Speaking Span Test

The Speaking Span Test (SST) is another complex span task frequently used to measure WMC. Originally, it was devised by Daneman and Green (1986). It is based on the assumption that differences in WMC could account for variation in language production, which is regarded as a complex cognitive task that needs coordination of both storage and processing of information throughout the stages of speech production. Hence, it is postulated that individuals with larger WMC could perform better on tasks measuring language production. The test consists of sets of unrelated words demonstrated on a computer screen. It involves (60) words in total divided into three sections (20 words in each) that show up in separate blocks of (2), (3), (4), (5), (6) words respectively, separated by blank pages. The subject is required to read out the displayed words in a consecutive manner and not to make stops. At the end of each block, whenever a blank page appears, s/he is required to produce

aloud a semantically and grammatically acceptable sentence for each word they could recall in the original order in which it appeared in the presentation. The produced sentences are written down on a scoring sheet by the researcher. The subjects' speaking span is then calculated. To do so, we divided the sum of the sentences which the subject has produced by the total number of words involved in each set (out of 20).Parenthetically, the sentences containing significant grammatical mistakes or with ambiguous meaning are crossed out and not counted. Thus, a subject who can produce (10) sentences out of (20) in each set will have a speaking span of (0.5).

 To illustrate, the first block in set 1 contains two words to be recalled and put into sentences:

● **Opportunity**

● **Time**

Below, are two example sentences produced by one subject (the target word is italicized and underlined):

1. "I didn't have the *opportunity* to have my lunch."
2. "I did not have much *time* to do my homework."
Also worth noting, the target words used in the SST are the same ones used in the previous RST. Finally, every subject in the sample has taken the test individually next to a computer screen in an empty quiet classroom. Besides, the time spent by each subject is also recorded by means of a stopwatch.

4.3.3.1. Results and Discussions of the SST Scores

<p style="text-align:center">Table 4.12. The Means of the SST Scores</p>

	Set 1	Set 2	Set 3	Total	Timing
Means (M)	12,325	12,05	10	34,625	25,725
SD	2,33575881	2,70753933	2,97855584	7,14569083	3,88281883

Table (4.12) demonstrates the means of the scores obtained by the (40) subjects after taking the SST of WMC. The score of every subject is given on the basis of his or her ability to recall as many words shown on the screen as s/he could, and then to put them in grammatically correct sentences with a clear meaning. The means of the scores in each section are achieved by gathering the scores of all subjects and dividing the total by 40. In section (1), the highest score achieved was (18) produced sentences out of 20, while the lowest recorded score was (8) sentences out of (20) (M=12.32; SD=2.33). In section (2), the highest recorded score attained (18) out of (20), whereas the lowest score decreased to (8) out of (20) (M=12.05; SD=2.70). In section (3), the highest score attained again (18) out of (20), while the lowest score stood at a minimum of (5) out of (20) (M=10; SD= 2.97). It was observable that the performance of the subjects relatively decreased in the third set. The total score represents the sum of the three sections. The highest score was (50) sentences out of (60), while the lowest score was (21) out of (60) (M= 34.62; SD=7.14). As for timing, the SST was more time-consuming compared to the RST. The time allocated for testing sessions ranged between (20) and (30) minutes (M= 25.72 min.; SD=3.88). (See Appendix 19).

Table 4.13. The SST Mean Spans in Each Set

	Span 1	Span 2	Span 3	Total span
Means (M)	0,61625	0,6025	0,5	0,57708333
SD	0,11678794	0,13537697	0,14892779	0,11909485

Figure 4.5.The SST Total Scores
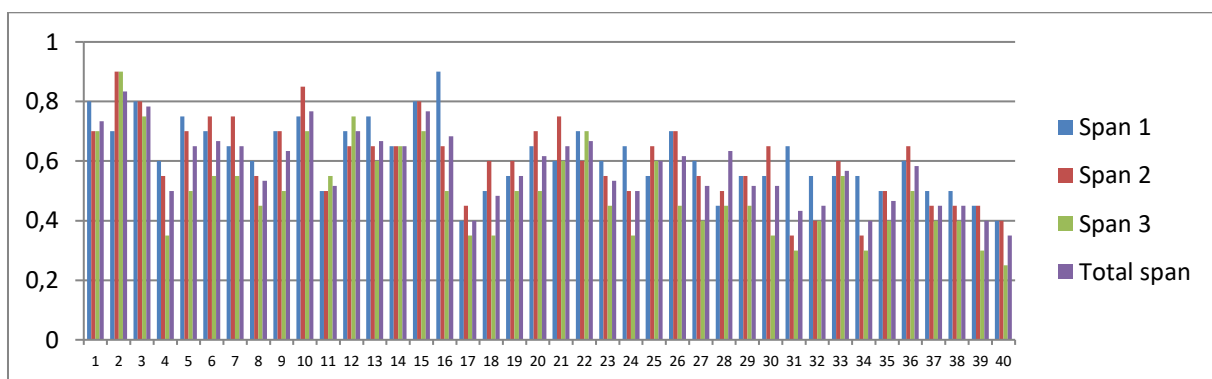
Table (4.13) and figure (4.5) reveal the means of the speaking spans obtained by the (40) subjects. Similarly, the span of a subject represents the total number of sentences that he or she has produced divided by the total number of words shown. Then, the mean span is worked out by gathering the spans of all subjects and dividing the sum by 20 (the number of words involved in each section). In section (1), the highest span attained (0.9); conversely, the lowest span was (0.4) (M= 0.61; SD= 0.11). In section (2), the highest span is again (0.9); on the other hand, the lowest span was (0.4) (M= 0.6; SD= 0.13). In section (3), the highest span was (0.9), while the lowest span was remarkably low (0.25) (M= 0.5; SD= 0.14). Notably, the performance in section 3 curiously diminishes to lower levels. The mean of the total spans— the sum of the spans in the three sets—ranged from (0.73) as highest to (0.35) as lowest (M= 0.5; SD= 0.11). (See Appendix 20).

Table 4.14. Mean Percentages of the SST Scores

	Section 1	Section 2	Section 3	Total
Means	61,625	60,25	50	57,7083333
SD	11,6787941	13,5376967	14,8927792	11,9094847

Table (4.14) highlights the mean percentages of the SST scores of the entire sample. Then, the scores of the subjects in each section are interpreted into percentages to reflect the variance in their WMC when it comes to processing and producing verbal information. In each section, the percentages are summed and divided by the number of participants (40) to calculate the mean. In section (1), the highest percentage was (90%); in contrast, the lowest percentage was (40%) (M= 61.62; SD= 11.67). In section (2), the highest percentage is (90%), while the lowest percentage was (40%) (M= 60.25; SD= 13.53). In section (3), the highest percentage was (90%), but the lowest percentage significantly decreased to a minimum of (25%) (M= 50; SD=14.89). Seemingly, the decrease in the scores in section (3) might imply that the recall and production of verbal material became more demanding which

apparently impacts the WMC. Finally, the means of the total percentages ranged between (83.33%) as highest to (35%) as lowest (M= 57.70%; SD= 11.90).

As can be perceived from the above results, the variance in the achievement of the subjects in the SST is considerable. Therefore, this mirrors the extent to which measurement of WMC can reveal individual differences in language processing and production among learners. Equally, the performance on such a test clearly reveals the implication of the WM functioning and its impact on one's ability to simultaneously store and process verbal information (dual-task switching), to sustain attention and resist distractions. This might be an explanation for the decrease of the subjects' performance as the test progressed, particularly in section (3), considering that the task is cognitively demanding and takes more time. As a result, the cognitive overload is another factor to take into account.

Conclusion

To summarize, the WM is central to the accomplishment of a variety of cognitive processes. It is chiefly responsible for holding, manipulating and retrieving information in interaction with both STM and LTM. Several theoretical assumptions regarding the WMC suggest that it is implicated in processing different types of informational knowledge, focusing attention and multi-tasking. Consequently, numerous tests have been designed, each of which targets particular features of the WMC. In the present work, we used two prevalent tests of WMC that essentially measure individual abilities in comprehending and producing verbal information. The performance of the subjects on both tests divulged a remarkable variance in WMC in coping with verbal tasks.

In the RST, the test administered to measure the subjects' abilities to comprehend and recall words of varying frequency levels, the obtained results showed a variance in scores that ranged between (29) and (53) out of (60) successfully recalled words. The mean of scores was around (39.98). Concerning the reading span, data have shown that it ranged between (0.48)

and (0.88) with a mean of (0.69). Finally, the scores were transformed into percentages. It has been found that the mean percentages of the scores ranged between (48%) and (88%) with a mean of (66.64%). Moreover, the time allocated to each testing session ranged between (8) and (14) minutes per individual. Accordingly, the results illustrate that the scores obtained by the subjects are slightly above the average.

In the SST, the test given to gauge the subjects' abilities to comprehend, recall and reproduce verbal material, yielded results that have also demonstrated a noticeable variance of scores across subjects when coping with such a task. The scores ranged between (21) and (50) out of (60) successfully produced sentences containing the target words, with a mean of around (34.62). As for the speaking span, the scores revealed that the spans in the sample ranged between (0.35) and (0.73) with a mean of (0.5). After converting the scores into percentages, we found that the percentage of the highest score was (88.33%), while the percentage of the lowest one was (35%) with a mean percentage of all scores around (57.70%). Additionally, the time devoted to testing sessions ranged between (20) and (30) minutes per testee. Similarly, the subjects scored slightly above the average but relatively lower compared to the scores they obtained in the RST.

Important to note, a number of factors seemed to impact the performance of the subjects on the tasks; these include, the level of frequency of the target words (words of higher frequency level are better recalled), the length of the words (words with more syllables necessitate more processing and highly more to forgetting), the effect of distractions (the attention of the subjects is sometimes disrupted) and frustration (some subjects appeared quite anxious). Another point to consider, the SST carries a more cognitive load and proved to be more effortful than the RST. This is clearly reflected in the differences in time consumed in each test as well as the significant fluctuation of the scores across subjects in the SST compared to those in the RST. As a result, on the obtained results confirm the first hypothesis

formulated at the outset of the paper; that is, WM mechanisms affect EFL students' lexical competence.

4.4. The Correlational Analysis

4.4.1. Introduction

As a conventional statistical procedure relied on in research, and to attain the ultimate aims of the study, a correlation analysis was carried out to examine the relationship between the subjects' WMC and their lexical receptive and productive knowledge. It is expected to evaluate the strength and direction of the relationship and the association between the variables. To do so, a correlation coefficient symbolized by the lower-case letter "r" is between each two variables, which can range between (-1) and (+1). The type of correlation used is the Pearson product-moment correlation, which is a standard type calculated between two continuous variables to describe a linear association. The formula used to determine the strength of the correlation and to calculate the correlation coefficient is as follows:

$$r_{xy} = \frac{N\Sigma XY - \Sigma X.\, \Sigma Y}{\sqrt{N\Sigma X^2 - (\Sigma X)^2}\, \sqrt{N\Sigma Y^2 - (\Sigma Y)^2}}$$

where
r_{xy} = Product moment coefficient of correlation between X and Y variables
ΣXY = Sum of product of X and Y
ΣX = Sum of the scores of X variable
ΣY = Sum of the scores of Y variable
ΣX^2 = Sum of square of X
ΣY^2 = Sum of square of Y

More specifically, two correlations coefficients (r_1) and (r_2) were calculated to compare the percentages scores obtained in the vocabulary tests and memory tests. On the one hand, the VST percentages of the scores are compared with the ones achieved in the RST (receptive knowledge association). One the other hand, the percentages of the scores of the PVLT are compared with the ones obtained in the SST (productive knowledge association).

4.4.2. The Correlation between the VST and RST

First, to examine the relationship between the subjects' WMC in terms of their abilities to comprehend and retain words with their abilities to recognise and comprehend words of varying frequency levels (receptive knowledge and abilities association), a correlation coefficient (r_1) was calculated based on the percentages of the scores they obtained in the VST and the scores obtained from the administration of RST. After applying aforementioned formula of calculating the coefficient, the following results were found:

Table 4.15. The Correlation between VST and RST Scores

Tests	VST (%)	RST (%)
Means	42,6	34,35
SD	12,17	10,1133181
r_1	0,597	
Significance Correlation	0,000 **	

N = 40

**: Highly significant correlation

r: correaltion coefficient

SD: Standard Deviation

As can be seen in the correlation table (4.15) above, the correlation coefficient r_1=.597 indicates a strong positive association between the scores. Next, the value (p <0.000) indicates a highly significant correlation. It can be summarized that the participants' performance on the vocabulary test VST, their abilities to recognize and identify the meaning words, strongly correlates with their performance on the memory test RST, which measures their abilities to comprehend and retain words. Hence, the obtained results partially confirms the second hypothesis of the research work and shows that the students' WMC to comprehend and recall words is, to a large extent, related to their receptive lexical knowledge at varying frequency levels ranging from high-frequency to low-frequency vocabulary.

4.4.3. The Correlation between the PVLT and SST

Second, in an attempt to enquire the relationship between the subjects' WMC with focus on their abilities to retain and produce words with their abilities to use words at varying frequency (productive knowledge and abilities association) in a variety of contexts, a correlation coefficient (r_2) was calculated based on the percentages of the scores that they achieved in the PVLT and SST tests. The following results were yielded:

Table 4.16. The Correlation between PVLT and SST Scores

Tests	PVLT (%)	SST (%)
Means	41,5	45,0357143
SD	16,7562644	12,0454387
r_2	0,73	
Significance Correlation	0,000 **	

As can be noticed in the correlation table (4.16), the correlation coefficient r_2= .73 which is interpreted as strong relationship between the results obtained in the two tests. As well, the value $p < 0.000$ reveals a highly significant correlation. Therefore, the subjects' performance on the PVLT, administered to assess their abilities to comprehend and use words, strongly correlates with their performance on the SST, given to measure their abilities to retain and use words in different contexts at varying frequency levels. Correspondingly, the obtained results offer a partial answer to the second research hypothesis raised at the outset of the paper and allows concluding that the students' WMC to retain and use words is, to a large extent, linked to their productive vocabulary knowledge.

Conclusion

In summary, after conducting and an assessment of vocabulary knowledge and a measurement of the WMC among the subjects, a further analysis was carried out to test the strength of the association between the scores. Two Pearson product-moment correlation

coefficients were calculated. Firstly, a correlation coefficient between the scores obtained in the VST and RST was computed; and consequently, a high positive correlation was found (r_1= .59) between the subjects' abilities to recognize lexical items of various frequency levels and their memory abilities to comprehend and recall items (receptive knowledge). The second correlation coefficient comparing the scores achieved in the PVLT and SST also revealed a high positive correlation (r_2= .73) between the subjects' abilities to produce words belonging to different degrees of frequency and their mnemonic abilities to comprehend, recall and reproduce words belonging to different degrees of frequency in different contexts (productive knowledge).

Conclusion

The present work calls into question the implication of variance in WMC in lexical competence among EFL students. To fulfill the aims of the study, two vocabulary tests and two memory tests were given to a sample of (40) Master 1 students enrolled at the Department of English at the University of Frères Mentouri Constantine 1.

As for vocabulary assessment, first vocabulary test, the VST, basically assessed the subjects' abilities to recognize and comprehend lexical items (receptive lexical knowledge) of different frequency levels in short contexts. The results showed that the size of most subjects lexical repertoire ranges between (5000) and (8000) words families which is considered as a mid-frequency vocabulary. A second vocabulary assessment tool, the PVLT, mainly designed to assess the subjects' abilities to produce words of varying frequency degrees, revealed that the subjects' productive lexical knowledge was comparatively lower in that the frequency level over which they showed an adequate mastery was the (3000) level, that is regarded as high-frequency words only.

Dealing with the WMC measurement, a first widely used test, the RST, was administered to measure the subjects' abilities to comprehend and recall a maximum number

of words. The obtained scores indicated that the mean score of the whole sample was around (39.98) (66.64%) out (60) successfully recalled words; the mean reading span was (0.69). the testing sessions lasted between (8) and (14) minutes per individual. Thus, the performance of the subjected was not significant as they scored slightly above the average. A subsequent test, the SST, designed to gauge the subjects' abilities to recall and produce words of varying frequency level in semantically and grammatically meaningful sentences. The results demonstrated that the mean score of the whole sample (36.62) (57.70%) out of (60) successfully produced sentences, while the mean speaking span was 0.5. The testing sessions lasted (20) to (30) minutes per individual. Therefore, the performance on the SST was also slightly above the average and seemingly more cognitively demanding.

Lastly, in order to attain the ultimate goal of the study the scores obtained in the tests were compared by means of a correlational analysis calculating the Pearson Product Moment correlation coefficient to determine the strength of association between the WMC and students receptive and productive vocabulary knowledge. The findings were a high positive correlation (r_1= .59) between the subjects' lexical in recognizing and comprehending words and their abilities to comprehend and recall words, a characteristic function of the WM. Equally, a high positive correlation (r_2= .73) was found between the subjects abilities to use words in diverse contexts and their abilities to recall and reproduce words in meaningful sentences, another operation linked to WM functioning. The factor of word frequency as an important aspect of word knowledge was applied in the four tests. Therefore, such findings answer the research questions and prove remarkably consistent with the assumption that WM functioning underlies individual differences in vocabulary building and that variance in WMC is strongly associated with foreign language receptive and productive lexical knowledge.

Chapter Five

Teachers' and Students' questionnaires

Introduction

The present chapter sets out to generate qualitative data about the cognitive and psychological processes underlying the process of foreign language learning with a primary focus laid on the relationship between memory processes and vocabulary development among EFL students. More specifically, it aims to touch on some aspects of the WM, and how they relate to lexical development as a fundamental part of the process of language learning in a systematic and disciplined manner. To fulfill this objective, two questionnaires, one designed for teachers and another for students, were administered at the Department of Letters and English at the University of Frères Mentouri Constantine 1. Both questionnaires comprise series of open-ended questions formulated to elicit both teachers' and students' insights and assumptions to acquire an in-depth understanding of the topic under scrutiny. Emphatically, the choice of open-ended questions format may be justified by the intention to obtain a precise feedback that might profoundly inform the survey. Moreover, the participants' responses are expected to complement the previous part (chapter 4), and to add to the conclusions drawn from the quantitative data analysis.

5.1. The Teachers' Questionnaire

Teachers are supposed to be a valuable source of information that would significantly contribute to the attainment of the study's objective. A questionnaire was delivered to 10 teachers of several subject matters. At a broader level, it was given to elicit their attitudes and perceptions of the impact of a number of cognitive and psychological factors on language learning. At a narrower level, it laid more emphasis on the implications of some characteristic features of WM in language learning as well as the process of vocabulary development. All the questions came in an open-ended format in the hope that it would yield more precise   and elaborate explanations.

5.1.1. The Participants

A randomly chosen sample of participants responded to the questionnaire. It comprised 10 teachers at the Department of Letters and English at the University of Frères Mentouri Constantine 1. The sample incorporates (4) (40%) male teachers and 6 female teachers (60%) who teach several modules, hold various academic degrees (doctoral students, Doctors, Professor) and have fluctuating teaching experiences (from 04 to 35 years).

Table 5.1. Table of The Participants

	Degree			Gender		Teaching Experience (Years)
	Doctoral Student	**Doctor**	**Professor**	**Male**	**Female**	
Subjects	1	6	3	4	6	18.1

5.1.2. Analysis of the Transcriptions

This section primarily deals with the analysis of the various responses provided by the teachers to the (22) open-ended questions incorporated in the questionnaire, which address the main issues enquired in our study. The teachers' responses are assumed to echo their understanding and consciousness of the ways in which cognitive processes and psychological factors underlie the EFL students' abilities to cope with language learning tasks, and how they might determine their academic potential; in particular, the association between memory functioning and vocabulary knowledge enrichment.

Question 1: What are the cognitive processes that substantially contribute to the process of foreign language acquisition/learning?

Question (1) is formulated to explore the teachers' awareness of the cognitive processes that play a pivotal role in the process of foreign language acquisition. The respondents' stated several processes that mainly included:

- Focus of attention, perception, reflection on one's learning, the ability to recall informational knowledge, rehearsal and storage, knowledge transfer and problem-solving, reasoning, intelligence, input/intake absorption,

The list involved some major inter-linked cognitive processes that indeed, according to research, largely contribute to language learning, and that seemingly have much to do with memory operational systems.

Question 2: What sort of psychological factors that would influence the process of foreign language acquisition/learning?

Question (2) aims to have a global idea of the types of psychological factors that significantly impact the process of language learning. The respondents' acknowledged a wide variety of contributory factors that essentially embrace:

- Motivation level, attitudes towards the culture of a the TL, self-esteem, self-confidence, anxiety and shyness, self-efficacy, fear of making mistakes, self-regulation, aptitude, and the teacher-student rapport.

Indeed, all of the above factors are believed to play a crucial role in the process of language learning. Further, they are, to the present time, receiving much attention in inter-disciplinary research.

Question 3: What types of language learning difficulties are frequently faced by students?

Question (3) concerns the potential difficulties and drawbacks that teachers believe students recurrently encounter when coping with language learning tasks. The respondents suggested ample of types; these primarily include,

- Lack of vocabulary, lack of interest in learning (low motivation level), anxiety, lack of background knowledge, speaking and pronunciation difficulties, poor grammatical

mastery, inability to focus attention when listening, poor spelling, lack of reading comprehension, laziness, problems with fluency, forgetting instructional knowledge.

The aforementioned list mirrors the teachers' familiarity with a diversity of learning obstacles faced by learners, most of which are largely reviewed as problematic issues that create individual differences among learners in the literature. Moreover, setting effective strategies to overcome such issues would certainly lead to the enhancement of the learners' academic performance and achievement.

Question 4: To what extent does memory affect the language learners' academic achievement and outcomes?

Question (4) basically targets one of the core aspects investigated in our research work, the impact of the students' memory capacity on their performance and outcomes. All of the respondents confirmed that it has a deep effect and offered various clarifications about the matter; they can be listed below:

- It helps learners to link newly learned material to what is already known.

- It largely contributes to the retention of vocabulary and grammatical rules.

- It makes learners save knowledge for future use (to tackle new tasks).

- It improves language comprehension and production.

- Poor memory significantly hinders the learners' performance.

In a word, memory is beyond doubt absolutely necessary to learn and plays a central role in academic achievement. Besides, promoting the students' abilities to effectively use their memory resources would crucially help optimize the learning outcomes, which is an objective to fulfill by both teachers and students.

Question 5: In what types of language learning tasks is the functioning of memory deemed a primary requisite?

The purpose of question (5) is to identify the extent to which different types of language learning tasks depend on memory operational systems. The answers might be summarized in the following statements:

- Reading and writing intensively and extensively.

- Retaining "ready-made" expressions such as idioms and formulaic sequences to promote fluency.

- Speaking and writing tasks.

- "Almost all areas of language learning"

- In productive tasks which require recalling already processed information.

Memory is a requisite to deal with almost every language learning task. Markedly, the respondents seemed to lean more to the idea that memory is more needed in the accomplishment of the productive tasks (writing and speaking) rather than the receptive tasks (listening and reading).

Question (6): What types of memory mechanisms are you familiar with?

Question (6) is intended to inspect the teachers' familiarity with the nature of memory mechanisms and functioning. The respondents have given answers that quite differ.

Some indicated that memory mechanisms have to do with the LTM (life-time consolidated information), STM (storing information for short periods) and retrieval (use of stored information). Other respondents suggested that they embrace repetition (drills), chunking (grouping words), and meaningful processing (relating new material to an already existing one in memory). Still others postulated that memory mechanisms refer to using diaries, journals, note-taking, creating networks of ideas to be conveniently remembered at a later time.

In brief, though the answers seem pertinent to memory functioning, there was no common ground for the responses in that some respondents referred only to the memory types; others focused solely on functions; while others stated only some mnemonic strategies often used to retain better; that is, each of which have sticked to only one aspect.

Question 7: How well can students retain the instructional material provided in the classroom?

Question (7) sets out to elicit the teachers' perceptions of the learners' capacities to memorize the instructional material delivered in the classroom. Most of the respondents argued that memory capacity differs from one student to another. Additionally, they have suggested cases in which learners retain and recall information more efficiently. For instance, when the material presented in a well-organized way, developing memory strategies and using memory aids such as note-taking, having an adequate background knowledge, paying more attention to the material, rehearsing intelligently (mind-shuffling), and maximizing practice .

Indeed, there exists a variance across learners when it comes to using memory resources adequately to tackle language learning tasks as demonstrated in the quantitative section of the study. Nonetheless, by virtue of its paramount importance, the improvement of memory capacity remains a principal objective to attain in every instructional programme.

Question 8: Do students face difficulties in memorizing linguistic input? If yes, what sort of it is hard to retain?

Question (8) is aimed at determining, from a teacher's perspective, the sorts of instructional material that learners often find difficult to retain. The respondents described a number of situations in which problems of memory among some learners show up when dealing with the linguistic input. For example:

- When the material refers to an abstract, unfamiliar and/or a complex concept.

- Sometimes they find it hard to retain totally new information that they do not have prior knowledge about (inherently, they cannot sustain attention for long).

- They often find difficulties in retaining words that are less frequent in the language (low-frequency vocabulary), idioms, and collocational knowledge.

- Avoiding using words that they do not pronounce properly, and that usually fade away from their lexical stores.

- When they don't use effective strategies to process the material to make it comprehensible.

- When they cannot draw on their L1 conceptual knowledge.

Seemingly, as the answers imply, the consolidation of linguistic input requires the ability to maintain and process information, to retrieve information from LTM, and to focus attention which are characteristic features of the WMC. Besides, most of the difficulties that learners encounter have much to do with vocabulary knowledge.

Question 9: How well can learners retain information performing on several tasks simultaneously (e.g. conversation, listening and taking notes)?

Question (9) focuses on multi-tasking or dual switching when coping with language learning tasks, a cognitive ability that largely depends on the WM operational mechanisms. Most of the respondents stressed that promoting this ability among learners depends on the extent to which the tasks are demanding as well as the amount of efforts they devote to cope with them. With this in mind, they asserted that a considerable number of students are unable to perform on two tasks simultaneously; they prefer to do one at a time. One respondent added that "female students tend to be more skillful in multi-tasking activities and can devote adequate attention compared to male students."

Question 10: How do you evaluate learners' attentional level and resistance to distractions during classroom activities?

Question (10) attempts to examine how teachers judge the learners' abilities to focus attention and resist different distractions (e.g. noise, interruptions) during lectures. As reviewed in the literature, controlling attention and resisting distractions to accomplish a task at hand are key functions of WM to maintain and process information. The majority of the respondents argued that this capacity varies from one student to another: some students grasp what is being delivered at once, while others require more elaboration. It is tied to the extent to which they find the instructional material interesting and motivational. Therefore, the factor of motivation seems to be worth considering when it comes to speaking about this characteristic feature of the WMC.

Question 11: How well does the learner recall information that s/he knows whenever asked?

Question (11) touches on a major issue addressed in our research work, the abilities of foreign language learners to recall informational knowledge. This process has to do with the ability of retrieving different sorts of information stored in the LTM, which believably draws on the WM functioning. The respondents considered that retrieval and recall abilities vary from a learner to another—as it is also manifested in the quantitative study of the paper. Some postulated that proficient students can easily recall information in a short time, while others with lower proficiency levels find it quite effortful. They also indicated using memory aids such as note-taking and repetition of key points do facilitate the recall. Furthermore, one respondent pointed out that a number of learners can remember information but find some difficulties in presenting it. In other words, they are limited by the inadequate linguistic mastery to produce language.

Question 12: What strategies do you employ to minimize the overload of the instructional material that you deliver?

The instructional material may carry a cognitive overload that certainly impacts the students' WMC in terms of processing and storage. Thus, question (12) is aimed at having an idea about teachers' attempts to reduce the overload to make the material easier to process and store. The respondents suggested numerous strategies; these include:

- Simplifying the academic discourse, giving realistic examples from the students' environment, and using diagrams.

- Engaging the students in cooperative/collaborative activities.

- Creating a relaxed atmosphere

- Outlining the key points on the board.

- Asking students to summarize key points only, instead of recalling large amounts of information.

- Encouraging memory strategies; for instance, chunking, repetition and meaningful processing.

In brief, the aforementioned strategies sound effective in reducing the amount of information to be processed and recalled as far as they seem to contribute to make the material more absorbable.

Question 13: What pedagogical strategies do you rely on to enhance learners' abilities to retain, recall and retrieve information?

The aim of question (13) is to enumerate the instructional procedures followed by teachers to develop the learners' mnemonic strategies leading to a more efficient retention and consolidation of material. The respondents proposed a range of strategies that can be summarized as follows:

- Encouraging note-taking, encouraging plentiful exposure to input (e.g. television and radio news), giving paraphrasing and summarizing assignments, preparing and presenting reports orally in the classroom, encouraging reading, brainstorming to relate new material to prior knowledge, engaging learners in communicative activities, encouraging students to ask questions (animated debates), using cyclical teaching (teaching-advance-step back technique), highlighting important words.

The respondents proposed a wide diversity of strategies that urge students to use their memory resources more adequately. Nonetheless, as demonstrated in the WM tests, there exist a remarkable fluctuation in their capacities, which suggests a further enquiry of how to attain such an objective.

Question 14: Does the performance of learners on tests and exams clearly reveal their cognitive and psychological strengths and weaknesses?

The purpose of question (14) is to elicit the beliefs that teachers hold about the efficiency of evaluation in diagnosing cognitive and psychological strengths and weaknesses. Typically respondents agreed that tests and exams are, to a certain extent, effective in revealing cognitive and psychological strengths and weaknesses. They clarified that it is not always the case because some factors interfere; for instance, anxiety, the overloaded schedule of exams, the learners' tendency to learn everything by heart, which may negatively impact their performance. Instead, constant assessment, in the classroom, may prove helpful in reflecting their real levels.

Question 15: Do students have problems with vocabulary acquisition/learning?

Question (15) is concerned with the second variable in the research question, the development of foreign language lexical knowledge. As anticipated at the outset of the paper, the quasi majority of the respondents confirmed that a considerable number of students are faced with the problem of a limited repertoire of lexical items which exerts a negative

influence on their abilities to cope with the TL learning tasks, namely their linguistic and communicative competences.

Question 16: What aspects of word knowledge (e.g. meaning, use, collocation, level of frequency, etc.) do learners find hard to learn?

Question (16) is intended to lay out the aspects of lexical knowledge, reviewed in the literature, which learners find most difficult to master. The respondents mentioned several aspects listed below:

- Expression of abstract conceptual ideas, affective expressions (referring to feelings and emotions), cultural aspects.

- Vocabulary use in different contexts, low frequency words (students are passive).

- Word meaning, collocations and idioms.

- Poor pronunciation.

The respondents attributed this issue to the lack of reading and the inadequate learning strategies the learners use to broaden their knowledge of words. However, the aforementioned list does not seem to involve all of the aspects.

Question 17: What signs, you might have observed, indicate that a number of learners have a limited lexical knowledge?

Question 17 explores chiefly the language learning areas in which the paucity in vocabulary knowledge clearly shows up. In other words, on what basis the teachers judge the learners' vocabulary as being limited. Accordingly, a number of indications were provided:

- Undeveloped fluency: long silence, no intonation, breath-gap, hesitation in speech.

- Constant repetitions of the same words even if it is possible use many alternatives in speech and writing; they use only the most frequent words.

- When they cannot give an answer to a question in a meaningful statement, even if they actually know the correct answer.

- Spelling mistakes and leaving gaps in writing.

- Asking peers or teachers in excess.

- The overreliance on the translator (they find in their cell phones) and bilingual dictionaries.

The cases described above clearly reflect the negative impact of having poor vocabulary in coping with language learning tasks in that it appears in almost all areas; particularly, using the language expressively.

Question 18: What learning strategies do learners frequently depend on to acquire/learn lexical items of the target language?

As reported in the literature review, students deploy a variety of vocabulary learning strategies, each of which targets particular aspects of lexical knowledge. Question (18) intends to explore the common ones that teachers are familiar with. The respondents mentioned a range of strategies and techniques that can be wrapped up in the following:

- Translation: many students use notebooks or the margins of their copybooks to write newly learned words with their L1 translational equivalents.

- Paper and electronic dictionaries, consulting peers and teachers

- Repetition/ chunking/meaningful processing

- Exposing themselves to different sorts linguistic input: listening to music, watching television shows, chatting with natives on the net.

Question 19: To what extent does learners' memory capacity contribute to their lexical mastery?

Question (19) focuses on the importance that teachers accord to the role of memory capacity in the development of vocabulary. It equally addresses the central issue enquired in the present paper. All the respondents accentuated that the memory capacity is implicated, to a large extent, to the process of vocabulary building. They postulated that memory capacity:

- can be an indicator of individual differences among learners as well as their learning styles and strategies,

- tremendously affects their performance on all language learning tasks,

- can be the way to sharpen up their skills (listening, speaking, reading and writing),

- impacts fluency,

- Interferes in the development of their communicative skills.

Question 20: Do learners encounter difficulties in retaining, retrieving, and recalling lexical items? If yes, in what types of learning tasks do they show up?

Question (20) seeks to reveal whether learners face difficulties in processing and storing lexical items and in what types of language learning situations it becomes noticeable by teachers. The respondents described a number of cases that can by summarized as follows:

- In tasks that require immediate and spontaneous use of the TL. For instance, being actively engaged in listening and speaking activities that demand oral fluency.

- In accomplishing writing assignments, poor lexical knowledge is plainly apparent.

- In the content based modules/tasks such as TEFL, literature, civilization, which require the manipulation of information through analysis and synthesis of content material.

In a nutshell, it seems that using language productively (speaking and writing fluency) puts heavier demand on memory processing.

Question 21: What instructional procedures do you often use to help students comprehend and use lexical items (i.e. receptively and productively)?

Question (21) inspects the potential instructional practices employed by teachers to optimize both receptive (passive) and productive (active) lexical mastery among language learners. The respondents reported a number of procedures that allow attaining such an objective. For example:

- Using definitions, giving ample examples, using language in context via classroom discussions, making reading sessions, games (e.g. "board race", "guess-the-word", "mind-maps", "beat-the-teacher"), cards and illustrations with beginning levels, group work/pair-work, warming up, fill-in-the gap activities, matching exercises (to teach words meanings), audio-visual aids, teaching idioms explicitly.

In short, the respondents have provided a wide range of strategies and techniques that actually target almost all aspects of lexical knowledge on the two primordial dimensions (receptive and productive).

Question 22: Does the performance of learners on tests and exams adequately reveal their strengths and weaknesses in lexical competence?

Question (22) elicits the teachers' perceptions of whether evaluation adequately unveils the learners' strengths and weaknesses in vocabulary knowledge. Most of the respondents confirmed that they do. A respondent explained that it is noticeable when students often find difficulties in giving the answer in semantically and grammatically acceptable statements even though it sounds like they know the appropriate answer.

Conclusion

The administration of the teachers' questionnaire has helped to obtain valuable qualitative data about the main issues addressed in the present paper. The 22 open-ended questions allowed achieving an in-depth understanding of the teachers' perceptions of the implication a number of cognitive, psychological and linguistic concepts in FLL academic achievement; specifically, the association between memory and vocabulary. There was a noticeable resemblance between the teachers' responses to the questions. Most of them have shown a high level of awareness of a number of cognitive and psychological factors underling language learning. Specifically, there have acknowledged that memory plays a crucial in learning a foreign language. Though teachers have not provided precise labeling of the

prevalent memory types and functions, they have described different situations in which the impact of memory is apparent, many of which is dependent on the WMC; for instance, they indicated that the consolidation and use of the instructional material heavily rely on the control of attention, the ability to process and manipulation of information, drawing on the information stored LTM, and being strategic in coping with tasks . As far as vocabulary is concerned, the teachers asserted that a significant number of learners encounter difficulties with vocabulary. Furthermore, many of the difficulties are attributable to WM functions.

5.2. The Students' Questionnaire

5.2.2. The Participants

The sample of subjects selected to participate in the questionnaire survey involved (20) participants chosen from the same sample of students that took part in the quantitative study (the subjects who took the vocabulary and WMC tests). The subjects within this survey are aged between (21) and (24) (Mean= 22.52) and have been academically studying English as a Foreign Language for a period that ranges from to (11) to (14) years (Mean=11.42).

Table 5.2. Table of Participants

	Mean Age (years)	Gender		Years Stadying English
		Male	Female	
Subjects	22.52	4	16	11.42

5.2.3. The Analysis of the Transcriptions

This section is devoted to the analysis of the students' responses to the (19) open-ended questions included in the questionnaire, which cover key concepts and issues addressed in the study. To further inform our study, the responses are expected to mirror the students' understanding and their levels of awareness of the major cognitive and psychological constructs that underlie the process of foreign language learning, particularly the relationship between memory functioning and lexical competence. They are equally anticipated to reflect their strengths and weaknesses in the focal learning areas under scrutiny.

Questions 1: What are the cognitive processes that you believe play a significant role in foreign language acquisition/learning?

Question (1) is aimed at eliciting the students' knowledge as well as levels of consciousness of the cognitive processes assumed to significantly contribute to the process of

foreign language acquisition/learning. The majority of the respondents have provided a wide range of processes among which there could be listed:

- Attention, encoding and storing information (memory), problem-solving, critical thinking, effectively analysing and synthesizing knowledge, reasoning (thinking logically), the ability to relate prior knowledge to new one, looking for limitations (being aware of one's weaknesses), and reflection.

Seemingly, most of the overstated processes are central cognitive processes and abilities that are believed, in abundant research literature, to play a major role in learning, particularly language learning. Furthermore, they remain to be thoroughly investigated topics regarding how they make differences among learners, how best to measure them and how enhance them to promote academic achievement. Finally, the importance of memory processes is acknowledged by most of the respondents.

Some respondents have mentioned some processes that do not directly address the question being raised; they stated some processes that seem quite ambiguous and impertinent such as age, motivation, "Stephen Krashen Theory", the brain, impulsiveness.

Question 2: What sort of psychological factors would influence the process of foreign language acquisition/learning?

Question (2) is basically framed to explore the respondents' familiarity with the types of psychological factors that impact, more or less, the process of language learning. The responses involved numerous factors that include:

- Intrinsic and extrinsic motivation, interest, curiosity, open-mindedness, aptitude, self-efficacy, self-esteem, fear of failure and low academic outcomes, stress and anxiety (obstacles for learning), type of personality, willingness and determination, positive attitudes, self-confidence, frustration and cultural shock, introversion and extroversion, and affective support.

The aforementioned factors are indeed regarded as crucial psychological factors that do affect the students' performance and achievement in tackling language learning tasks, negatively or positively, which reflects the students' intimate familiarity with. In particular, the contributory factors that are given greater importance are motivation, self-esteem and anxiety.

Some respondents, on the other hand, have listed some factors that do not precisely name the factors, but in some way seem quite relevant; for example, the classroom environment, social interaction, the teacher's guidance, trust, experience, background, and sense of responsibility.

Question 3: What type(s) of difficulties do you face when learning the target language?

Question (3) is shaped to explore the different sorts of difficulties and obstacles that students usually encounter when learning the TL. So, it aims to assess the respondents' abilities to diagnose such obstacles as part of the strategies they employ to facilitate the attainment of the learning objectives. They mainly included:

- Speaking in public (facing audience), lack of vocabulary when speaking and writing, inability to memorize new words occasionally, difficulties with pronunciation and speaking fluently in front of others, inability to recall the meaning of some words though they seem familiar, interference of other languages such as Arabic (L1) and French. Understanding specific regional dialects of native-speaking countries, making sense of the content of instructional material (some teaching methods seem not to be effective), mastery of grammar rules, difficulties in clearly expressing thoughts and ideas.

The respondents have mentioned various obstacles that they believe hinder their performance and achievement when learning a foreign language. Importantly, vocabulary knowledge, which is the main concern of the present study, is reported in most of the answers

as one of the major difficulties faced by students as long as it is needed in tackling almost all learning tasks.

Question 4: Do you see that your ability to memorize information affects your mastery of the target language? How?

Question (4) purports to elicit the students' perceptions of the extent to which their abilities to memorize informational knowledge influence their mastery of the TL and in which manner. The respondents have given a set of varying answers in regard to such a matter. The majority of them (90%) have agreed that the ability to memorize information profoundly impacts their mastery of the L1 in a way that:

- It facilitates reading comprehension; it allows making sense of the instructional material; forgetting the meaning of words necessitates the constant dependence on the dictionary; it enriches one's vocabulary and perfects grammatical mastery; it allows to communicate more effectively; it enables recalling the input especially if one uses efficient memory aids .

Only a minority of the respondents (10%) have denied the significant impact of mnemonic abilities on TL mastery. One stated that "not really! Language is not about memory and being robotic; it is about taking risks and using the language." Another claimed that "No! I don't think that language is about memorization of information; I think practice is the key element in mastering the four basic language skills [listening, speaking, reading and writing]."

Question 5: How well can you memorize the instructional material provided by the teacher(s)?

The objective of question (5) is to make a clear idea about the students' beliefs about their abilities to memorize the classroom input. The responses differed from one respondent to another and may be put under three categories.

Firstly, a minority affirmed that they perfectly memorize everything provided by the teacher. Secondly, a relatively large number of respondents revealed that they retain and recall the instructional material to a certain extent. They have provided several clarifications. For instance, some claimed that it depends on how interesting the instructional material is; others explained that they cannot memorize everything by heart, but rather rely on strategies like summarizing the salient points, paraphrasing, drawing diagrams and repetition; some respondents indicated that they can memorize visually presented material better than blocks of words; still others mentioned that it depends on the clarity of the presented material which is part of his or her teaching method. Thirdly, a minority argued that they find they have difficulties with retaining and recalling the material.

Succinctly speaking, it can be deduced from the responses that it is fair to say that the ability of the students' to memorize the instructional material crucially depends on the extent to which they find the classroom material comprehensible.

Question 6: Do you find that the instructional material and learning tasks delivered by teachers cognitively overloading?

The purpose of question (6) is to examine how cognitively demanding the learning tasks are perceived by the students, and which are considered as factors affecting the WMC. Such an issue created a state of controversy; (50%) of the respondents agreed that the material and the learning tasks are cognitively demanding in that:

- The number of modules (11 modules) is seriously overloading.

- Some lectures are complicated and long which makes it difficult to understand and memorize some points.

- The time allocated for sessions per day is tiresome which leaves less time for revision

- Some teachers over-rely on dictation and the delivery of large blocks of material which makes it quite difficult for some students to grasp everything and negatively affects their motivation level.

Conversely, a second (50 %) of the respondents denied the case that the instructional material is overloading and affirmed that it is rather helpful in a way that it enhances their cognitive abilities such as memory and critical thinking, especially if it is presented in an organized way.

Question 7: What type of distractions you face when studying (e.g. noise)? And how can you adequately resist them?

Question (7) attempts to identify the types of distractions that students often face when studying as well as the extent to which they may possibly resist them. The respondents have mentioned a variety of factors that disrupt their attention; these include:

- Crowded classrooms that tend to be noisy.

- Getting constantly interrupted by the teacher or a peer when dealing with a learning task.

- When the instructional material is not properly presented (not well organized).

- Animated discussions may also make it hard to concentrate on the learning tasks.

- The tendency to use the cell phone to access social networks or even to play games during sessions.

- High temperature and ill-ventilation in the classrooms.

- Hesitation of some teachers when delivering the instructional material.

- At home, the usual sources of distraction are television noise.

To cope with such a problem, the respondents have listed some strategies that help them maximize their concentration level. For example, taking the front seats in the classroom or amphitheatre, taking notes when the teacher explains, rehearsing the key points, ignoring

interruptions of other classmates, listening to quiet music (at home), and studying in quiet places away from electronic devices.

Distructors are highly likely to affect the WM functioning by the disruption of attention. Thus, minimizing the distractions in the studying environment and using effective strategies to resist them are highly likely to optimize the WMC.

Question 8: How well can you perform on two language learning tasks (e.g. Listening and taking notes) simultaneously?

Performing on two tasks simultaneously, or what is known as task-switching, is a characteristic feature of the WMC;therefore, question (8) was given to see how well the students can handle such a matter.

About (40%) claimed that they can deal with two learning tasks simultaneously. Particularly, taking notes while the teacher explains, engaging in discussions with the teacher, and using diagrams and abbreviations when reading a passage to facilitate understanding and recalling material. Another (40%) indicated that they can manage it to an average extent. They argued that they need to fully understand the idea being discussed before accomplishing a second task, which requires more practice to develop such a skill. Others assumed that it depends on the difficulty of the tasks. Finally, only (20%) admitted that they can do only one task at a time.

Question 9: Does your performance on tests and exams clearly reflect your cognitive abilities?

Question (9) strived to enquire students' convictions about whether their outcomes in the tests and exams adequately mirror their actual cognitive abilities. The majority of the respondents (90 %) affirmed their outcome in tests and exams does not really reflect their cognitive abilities. They have provided a number of explanations. For instance:

- Performance on exams relies heavily on rote learning (memorizing everything by heart).

- Some teachers set a threshold mark so that the students cannot have the full mark even if all of his/her answers are correct.

- Some exams do not evaluate the students' critical thinking and problem-solving abilities, but rather they assess the ability to store large amounts of information.

- Some factors such as stress, anxiety and fear of failure hinder the students' cognitive performance.

- Academic outcomes value grades rather than the students' skills and abilities.

Minorities (10%) of the respondents, on the other hand, have acknowledged that performance on tests and exams actually reflects their cognitive abilities. The responses imply that when designing a test or an exam, teachers are expected to take into account the diversity of cognitive processes as well as the students' strengths and weaknesses in. further, the more longitudinal evaluation is, the better informed the teachers will get about this concern.

Question10: What strategies do you often use to enhance your ability to memorize information?

Question (10) purported to generate ideas about the strategies and technique that students usually employ to retain and recall information effectively. Forthwith, numerous strategies have been suggested by the respondents. These incorporate:

- Making diagrams and visual aids such as colour codes to make a mental image of what is being presented, taking-notes, paraphrasing and summarizing, meaningful learning (relating new information to what is already known, repetition, highlighting key words and phrases, using drills, breaking down the instructional into smaller more manageable segments, mind-mapping and chunking.

Notably, the respondents claimed to use a large variety of strategies, each of which strives for a deeper processing of information which is recognized as a key role of the WM. However, despite the diversity of the strategies used by learners, the effectiveness of each strategy in enhancing WM functioning remains a worth examining issue.

Question 11: How do teachers methodologies help you retain and memorize better?

Question (11) touches on the effectiveness of the instructional procedures used by teachers in promoting the students' abilities to memorize the instructional material. The respondents described several situations where the teaching methods are successful in doing so. For instance,

- When the material is presented in an interesting way.

- If it is eclectic. That is it suits the students' preferences and learning styles

- When technology and visual aids are employed as facilitators.

- When they engage a maximum number of students through, for example, discussions and encouraging debates.

- Repeating key words.

- When the content is coherent.

- Making a recapitulation of the key points at the end of the session.

- Providing students with ample opportunities of what they have learnt and providing them with constant feedback.

- Using exemplification.

Though the list is not conceived as being exhaustive, it suggests that the efficacy of the teaching methods in optimizing the consolidation of the instructional material seems to globally depend on the extent to which they make the content more comprehensible, easier to grasp and interesting, which evidently allows a deeper processing of knowledge. Furthermore,

it is worth noticing that memory or mnemonic strategies are not explicitly taught as far as they are not involved in the list.

Question 12: To what extent does your vocabulary knowledge allow you to cope with all language learning tasks and activities?

The purpose of question (12) is to determine how adequate is the students' lexical knowledge in coping with different language learning tasks. (25%) of the respondents admitted that they have a satisfactory knowledge of words that allows them to tackle all language tasks. (20%) admitted that their lexical mastery allows them, to an average extent, to cope with tasks. (30%) affirmed that they have poor vocabulary knowledge. (25%) of the respondents might have misunderstood the question as they have spoken only about the benefits of having a rich vocabulary. In a word, the answers to question (12) seem inadequate since the respondents have not given sufficient explanations.

Question 13: What aspects of vocabulary knowledge (eg. form, mening, collocation, etc) seem to you difficult to learn?

The objective of question (13) is to delineate the primary aspects of vocabulary knowledge that the students find hard to learn. The responses can be summarized as follows:

- Words with multiple meanings.

- The written forms of words owing to the overreliance on listening.

- Idioms.

- Technical words.

- Phrasal verbs.

- The collocational use of words

Important to realize, the meaning of words predominated in the responses as the hardest aspect of vocabulary knowledge for EFL learners to master. Moreover, the

respondents did not appear to be fully aware of the diversity of the rest of aspects such as register, frequency of use, pronunciation, and so forth.

Question 14: What strategies do you employ to enhance your abilities to recognize and comprehend (through listening and reading) words you encounter in the target language? How effective would they be?

Question (14) concerns the learning strategies deployed by the students to build up their receptive vocabulary knowledge—a first dimension of lexical knowledge investigated in our research work— and the extent to which they are fruitful. A broad variety of strategies was suggested. It chiefly embraces:

- Watching movies with no subtitles.

- Guessing from the context in which the target word is encountered.

- Dividing words into sub-parts (prefixes, roots and suffixes).

- Drawing on knowledge of French vocabulary.

- Relying on non verbal cues.

- Jotting down unfamiliar vocabulary to look them out later in the dictionary.

- Rehearsal.

Therefore, it is worth remembering that the strategy that was recurrently reported by the respondents as way to enhance one's receptive lexical knowledge is guessing from context.

Question 15: What strategies do you use to enhance your abilities to produceand use (through writing and speech) vocabulary items in thetarget language? And how effective are they?

The focal point of question (15) is to enquire the strategies that students use to improve their abilities to use lexical units productively, which is a second dimension of an individual's vocabulary knowledge scrutinized in the present work. The responses may be classified as follows:

- Risk-taking.

- Attempting to diversify the words and expressions as much as possible in several contexts.

- Putting into practice the newly learned words through writing essays and novels.

- Using the TL outside the classroom; for example, by conversing with native speakers.

- Keeping a diary.

- Creating context for newly learned words.

- Through cooperative learning: trying to communicate with proficient speakers of the TL; for example, in book clubs.

- Trying to memorize 3 words per day by heart (rote learning).

- Watching movies and listening to dialogues, then trying to imitate native speakers.

- Using synonyms.

Markedly, the respondents' answers revealed that the use of lexical units productively in writing overweighs their use in speaking. This implies that using the TL in speech is more demanding and requires deeper processing which calls for maximum practice.

Question 16: How does your memory functioning impact your vocabulary knowledge?

Answers to question (16) are expected to target the core of our enquiry: the implication of memory functioning in EFL vocabulary knowledge. The respondents reacted differently to this issue offering varying explanations. The majority of the respondents confirmed that their memory capacity deeply affects their abilities to expand their lexical repertoires. They emphasized that they constantly need effective memory strategies such as visual aids to acquire and comprehend more words in diverse contexts alongside with forgetting which is reported as a recurrently confronted problem. On the other hand, a minority claimed that memory does not significantly impact their lexical knowledge. They supposed that vocabulary building is mostly dependent on psychological factors such as

anxiety. Such a response is hard to rationalize because it is impossible to deny the fact that memory is an absolute necessity to comprehend and use words.

Question 17: To what extent is the linguistic input you receive in the classroom sufficient to promote your vocabulary building?

Question(17) is intended to determine the point to which learners perceive that the instructional material provided by the teacher in the classroom enriches vocabulary. A number of respondents stated that the linguistic input is helpful to an average extent. They justified the case in the following quotes:

- "It's pretty mediocre compared to what you get from natives."

- "The input is solely limited to academic vocabulary, and some teachers tend to repeat the same words and expressions over and over making the input poorly diverse."

- "It is in sufficient in regard to the size of the English vocabulary, especially spoken English."

Alternatively, other respondents acknowledged that teachers are not expected to be the source of all the vocabulary they need, but rather it is supposed to rely on other sources to achieve this aim. So, the latter statement seems to be rational, but it is worth considering that teachers should take into account the significance of lexical richness and density of the material.

Question 18: What instructional strategies do teachers use to expand your vocabulary repertoires? Are they adequately effective?

There exist batteries of instructional procedures followed by teachers to promote the students' vocabulary building. Hence, Question (18) is aimed at exploring the kinds of batteries are most useful from the learners' perspectives. The respondents have provided a list including:

- Repetition and organization

- Role-plays, particularly in oral expression sessions.

- Some games such as "the hot-seat", "Pictionary", "hangman", and "crosswords".

- Rephrasing ideas and giving synonyms.

- Brainstorming at the outset of sessions (warm-up).

- Dialogues and cooperative learning strategies

- Reading assignment;

The respondents have not indicated the extent to which the instructional strategies are adequate; that is to say, what aspects of lexical knowledge they target. What it could be understood, however, that they find the aforementioned strategies most interesting.

Question 19: Are there any other sources you rely on to build up your vocabulary? If yes, what are they?

Lastly, the respondents are asked about potential sources they rely on to develop their lexical knowledge apart from the academic circumstances. The answers included a broad variety of types; namely:

- movies, video games, series, books, Mangas, Youtube tutorials and videos, lyrics of songs, chatting with natives, dictionaries, songs and so forth.

Obviously, such types of sources are among the most common ones that do provide significant amount of input. Nevertheless, what is conceived important is the degree of the exposure to and how effectively they are used to maximize their benefits.

Conclusion

The questionnaire designed for students has permitted gathering a copious amount of qualitative data about the main concerns of the study. The students' responses to the (19) open-ended questions have led to substantial findings about the learners' perceptions and beliefs about the impact of cognitive and psychological factors in the process of EFL learning, especiallythe contribution of memory resources to vocabulary development. It has been

revealed that students are aware of a wide range of cognitive and psychological factors that influence the process of language learning. Besides, students' seem to attach a great importance to vocabulary as being a necessity to cope with almost all language learning tasks. It has also been shown that comprehension and use of lexical knowledge depends on the characteristic features of WMC, namely, the abilities to focus attention, to manipulate information, resist distractions and overload of the instructional material, and so on. As a result, such findings are consistent with the findings obtained in the quantitative part of the study (the vocabulary and memory tests) and hence with the hypothesis that the WMC is strongly linked with the ability to comprehend and use vocabulary knowledge.

Conclusion

The two questionnaires were basically designed to generate qualitative data about the major concerns of the present research work. It serves as a complementary part to the quantitative study (chapter 4) devoted to the analysis of the results obtained from the administration of two vocabulary assessment procedures and two WMC measurement tools. The pattern of the responses of both teachers and students proved to be consistent with the findings of the quantitative findings. First, there exist significant fluctuations in the learners' WMC and vocabulary knowledge (both receptive and productive). Second, the WM functions, strategy—focusing attention, resisting distractions and cognitive overload, maintaining and manipulating informational knowledge, retrieving information from the LTM store—have been found to be considerably implicated in acquiring and using lexical knowledge of various aspects. Third, proficient learners use their WM resources more efficiently to comprehend and use the instructional material, to cope with different language learning tasks including vocabulary development.

Chapter Six

Overall Discussion and Pedagogical Implications

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Introduction

On the basis of what has been discussed in the theoretical reviewand the results obtained from the tests and the questionnaires, the present chapter is devoted to address the basic issues scrutinized in the study. Likewise, it attempts to offer some pedagogical implications and recommendations for future research. In essence, it takes into account the association between cognitive and psychological factors, particularly WM, and the development of lexical knowledge among EFL students.

6.1. Discussion of the Results

6.1.1. Variance in Students' Receptive Vocabulary Knowledge

Vocabulary enrichment is undoubtedly indispensable in language learning. It involves the enrichment of knowledge about a variety of lexical aspects: form, meaning, use, collocations, syntactic characteristics, constrains on use, and so on. In lexical research, receptive vocabulary knowledge is acknowledged as a primordial dimension of one's vocabulary. It refers to the ability to recognize and comprehend a word when it is heard or met in reading. In addition, knowing a word receptively entails knowing the min parts it could be made up of, knowing the concept behind the word that allows comprehension in various contexts, knowing other words that could possibly be semantically and grammatically connected with a particular one, knowing suitable collocations of words, knowing the degree of formality and the level frequency of a occurrence in the language (Nation, 2000).

The present study strived to assess EFL students' receptive vocabulary knowledge as part of L2 cognitive processing. Recognition and comprehension have to do with converting raw input into comprehensible representation. It involves the perception of lexical properties of given words in order to identify their familiarity and assigning meanings to. To do so, quantitative and qualitative sorts of data have been gathered via a test and questionnaires to determine the strength and weaknesses in students' receptive vocabulary.

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The VST (Beglar & Nation, 2007) allowed achieving estimates of the overall size of words that students know receptively across a range of frequency bands. Recent studies have shown that a vocabulary size of an adult educated native speaker of English is around (20,000) word families (Schmitt 2000; Nation, 2000). Other studies concluded that young native speakers of English expand their vocabulary repertoires by adding around (1000) word families a year from the age of two or three. This implies that a five native speaker beginning school would have a vocabulary size of about (4000) to (5000) words families (Waring & Nation, 1997; Nation, 2000). Concerning foreign language learners, Schmitt (2000) postulated that an advanced foreign language speaker is supposed to have a vocabulary size of about (15,000) word families. Thus, motivated with such considerations, the VST was given make general estimates of EFL Master 1 students at the Department of Letters and the English Language—University of Frères Mentouri Constantine 1. It is a widely used vocabulary assessment test designed to give overall estimates of the vocabulary size among non-native speakers. The VST is a multiple-choice test comprising 140 lexical items given provided in short contexts. Each item represents 100 word families. The items were chosen according to their levels of frequency of occurrence in the English language according to the BNC, and which range between high-frequency, mid-frequency and low frequency word families. It also assesses knowledge of various aspects including written form, meaning, word parts, concepts and referents, association, grammatical functions, and collocations. Importantly, the frequency factor is taken into account by virtue of its importance in the acquisition, processing and use of vocabulary. Ellis (2002, p. 152, In Schmitt, 2010) emphasized that "there are strong effects of words frequency on the speed and accuracy of lexical recognition (speech perception, reading, object naming, and sign production) […] in children and adults as well as in L1 and L2." (p. 63).

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The results of the VST test revealed that the highest vocabulary size was (10,200) word families, while the lowest size was about (2,400) word families with a mean of (6305) word families. On average, the participants scored mostly between (5,000) and (8,000) word families. Nation (2006) classified frequency levels into: high-frequency vocabulary of about (2000) words, a mid-frequency vocabulary (from 3000 to 9000) and low-frequency vocabulary (10,000 and more). He emphasized that, for receptive use, a learner requires about 6,000 word families to read novels written for teenagers, to watch movies, and to take part in friendly conversation; around 8000 to 9000 word families to read newspapers, novels and some academic text. Accordingly, the results obtained in the VST demonstrate that only one participant (2.5%) could attain a low-frequency level (more than 10,000 word familes) and be said to have a relatively high lexical competence; (2.5%) have a lexical repertoire limited only to high-frequency vocabulary, whereas the majority (95%) may be said to have a mid-frequency vocabulary. In sum, the result suggest that the students have a quite limited receptive vocabulary which still requires improvement to attain more advanced levels to cope with more diverse language tasks.

6.1.2. Variance in Students' Productive Vocabulary Knowledge

Productive vocabulary knowledge is also considered as a fundamental dimension of one's lexical knowledge. It refers to words that can be recalled and actively used in speech and writing. That is to say, knowing a word productively or expressively necessitates being able to pronounce it accurately, write it in accurate spelling, combine it with other word parts such as affixes, express it in a wide range of contexts, produce possible synonyms and antonyms for, produce the words it best collocates with, its degree of formality. (Nation, 2000).

The present study also aims to assess EFL students' productive vocabulary knowledge within the context of L2 cognitive processes. Typically, language production implies

transforming thoughts into words. An individual is assumed to undergo several stages; notably, conceptualizing what to say, selecting the pertinent information to build up an intended utterance, transforming the conceptual representation into linguistic forms, selecting and retrieving the appropriate lexical items stored in the mental lexicon (lexicalization), combining words to construct sentences with respect the syntactic rules of the language, setting an articulatory plan, producing linguistic output. Against this background, quantitative and qualitative data have been collected through a test and questionnaires to examine the variance in students' abilities to use vocabulary productively.

The PVLT , devised by Laufer and Nation (1999), is a fill-in-the-gap vocabulary test mainly designed to measure the productive vocabulary knowledge in non-native speaker at gradable frequency levels; that is from high to low-frequency words. The test is divided into five sections, each representing a frequency level and comprising (18) sentences of reasonable complexity with missing words within. It equally targets a number of aspects of word knowledge including written form, meaning, use, grammatical behaviour, collocation and constrains on use. The obtained results showed that the subjects' abilities to use words productivelyranged between (2000) and (3000) frequency levels (high-frequency vocabulary), and sharply dropped at higher levels (mid and high-frequency vocabulary). The results reflect a remarkably limited productive lexical knowledge. Besides, Compared to the VST results, the results proved that the subjects' receptive vocabulary significantly surpassed their productive vocabulary. Such findings indicate that more efficient strategies should be mapped out to enhance the students' abilities to achieve adequate levels of productive lexical mastery.

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6.1.3. Measurement of the Working Memory Capacity

The concept of WM is still attracting considerable interest in the cognitive research by virtue of the vital role it plays in highly complex cognitive processes; particularly, perception, attention, planning, reasoning, problem-solving, decision-making, intelligence and language. The present study draws on the tripartite framework of WM proposed by Baddeley and Hitch (1974), for it is widely accepted as a rational description of memory mechanisms. Accordingly, WM is a limited-capacity system that maintains, manipulates and processes information coming from both STM and LTM. In educational research, WM is intimately related to learning; it was found to highly correlate with mathematic and language abilities. Further, WMC is considered as a powerful predictor of scholastic achievement and success that differs from one individual to another. WMC commonly refers to one's ability to hold, process, store information; it has also to do with the ability to resist interference and distraction in the performance of a given cognitive task. As a result, different measures of WMC have been designed to gauge individual abilities to cope with tasks depending on WM operating systems. In the present research work, the main focus to measure the WMC among EFL students with respect to vocabulary comprehension and production. It deployed two complex span tasks: the RST (Daneman & Carpenter, 1980) for vocabulary recognition and retention, and the SST (Daneman & Carpenter, 1986) for vocabulary retention and production.

The RST provided valuable results in regard to EFL students' variance in WMC to recognise and store lexical items occurring at varying frequency levels in the English language. The subjects were required to read out sets of (60) sentences demonstrated on a computer screen and recall the last word in each sentence. The sentences were presented in blocks of (2), (3), (4), (5) and (6) sentences in each. The test incorporates three sections of (20) sentences in each. The frequency level of the words to be recalled is graded from high-

frequency to low-frequency vocabulary. Eventually, the total number of the words recalled in each section of sentences determines the reading span of the subject. The obtained results showed a significant variance in the subjects' performance. The scores ranged between (29) and (53) out of (60) successfully recalled words (mean= 39.98). Equally, the total reading spans ranged between (0.88) and (0.69). Ultimately, the scores were converted into percentages. The values ranged between (48%) and (88%) with a mean of (66.64%). Given these numbers, it may be regarded as certain that the subjects' performance in processing and recalling vocabulary items is slightly above the average.

Similarly, the SST unveiled a considerable variance in the subjects' WMC in terms of comprehension, recall and reproduction of vocabulary items of differing frequency levels. The subjects were asked to read out and memorize sets of words (60 words) displayed on a computer screen and then produce a syntactically and semantically acceptable sentence for each word. Like in the RST, the words were presented in blocks of (2), (3), (4), (5) and (6) words in each. The test involves three sections of (20) words in each. After writing down the subjects' production and crossing out the inaccurate sentences, the subjects' speaking spans were calculated. In sum, the subjects' scores ranged between (21) and (50) out of (60) successfully produced sentences involving the target words (mean= 34.62). likewise, the speaking spans ranged between (0.35) and (0.73). Turned into percentages, the scores ranges between (35%) and (88.33%) with a mean of (57.70%). On the basis thereof, the performance of the subjects in processing and producing lexical items, to a small degree, exceeds the average. In the same vein, the scores obtained in the SST are lower in comparison to the scores in the RST, which suggests that vocabulary production carries more cognitive load and depends on deeper WM processing compared to vocabulary recognition and comprehension.

6.1.4. Correlation between Lexical processing and Working Memory Capacity

The ultimate goal of the study is to determine the extent to which vocabulary comprehension and production—receptive and productive lexical knowledge—is related to WMC. To do so, a Pearson product-moment linear correlation was carried out. A high positive correlation ($r_1 = .59$) was found between the students' scores in the receptive vocabulary test and the RST of WMC. Similarly, a high positive correlation ($r_2 = .73$) was found between the productive vocabulary test scores and the SST of WMC. As a result, the obtained values answer the core question of the study indicating a strong relationship between receptive and productive lexical knowledge and the WMC among EFL students in the university context.

6.2. Pedagogical Implications and Recommendations

Based on what was reviewed in the literature and the findings obtained from the administration of the tests and questionnaire, this section aims to outline some pedagogical implications and recommendations pertinent to the principal objective of the study.

6.2.1. The Cognitive Approach

The present study was basically carried out to enquire how cognition processing is implied in foreign language learning. The cognitive approach regards individuals as information processors; it calls into question how mental processes allow humans to solve problems, make judgments, process newly encountered information to construct knowledge. Therefore, understanding the ways in which individuals' process information allows designing learning experiences that trigger the learners' cognitive processes to achieve ultimate outcomes. This section proposes a number of educational implications based on cognitive views to develop practical ways to help learners to process instructional material more efficiently.

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Learners are believed to perceive auditory and visual material differently; thus, educators need to take into account the amount and sort of information they wish to present and the pace at which it is presented. Educators should also minimize the number of distracting effects that would possibly disrupt the learners' perception of the presented instructional material. Additionally, the material should be strongly defined and appeal to as many senses as possible taking into consideration the differences in perceptual abilities among learners. Eventually, the material should be appropriately structured in a way that arouses the perceptual interest; for instance, through using charts, diagrams and stories.

Educators are also expected to capture and direct the learners' attention for it is an essential element for effective information processing. To do so, a learning experience should be sufficiently engage and suit the learning styles preferences and styles of the learners. For example, stimulating debates discussing underlying concepts, asking questions as departure activities can actively engage learners and arouse their interest. It is also worth considering that learners should be aware of what to attend to from the outset of the presentation by highlighting the key points and the main objectives they are required to attain.

The design and presentation of the instructional material should target the learners' abilities to use inductive and deductive reasoning in order to make valid judgments and properly evaluate what is being presented. Reasoning plays a vital role in thinking and cognitive. Accordingly, promoting reasoning would enhance the students' abilities to make successful inferences of what the educators intend to deliver; besides, it allows a deeper processing of information through relating what is already known to new information.

Problem-solving is another mental ability that largely contributes to learning. Learners are expected to use information to cope with situations involving some sort of obstacles. Educators need to help learners to approach problems in systematic manners. That is, they ought to polish the learners' skills of how to define and categorise problems, analyse and

break down the material into easily handled elements, synthecise the main portion of the presented material to make sense of the whole; such activities lead to fostering learners' convergent and divergent thinking.

6.2.2. The Working Memory Capacity

In view of the implication of WM operational mechanisms in the accomplishment of complex cognitive tasks and hence learning, the WMC is arguably a powerful predictor of academic performance. Moreover, the data gathered from the experimental section of the study revealed that subjects with high WMC scored significantly better in vocabulary tests compared to subjects with limited WMC. More importantly, a number of factors have been found to impact the subjects' performance such as the effect of distractions (factors disrupting attention), the mount cognitive load which the tasks carry, the level of processing, which are all believed to rely on WMC. As a result, it is suggested that the enhancement of WMC leads to better academic performance; particular to our case, language comprehension and use. Jordan et al. (2008, pp. 50-51) outlined a set of teaching practices to improve the learners' abilities to use WM resources to organize, store and retrieve material. Teachers should:

- tell learners which information is most important;

- begin with an overview or outline of the material to be learnt;

- state the objectives or learning outcomes of a learning session;

- develop automaticity and speed of response in learners through regular practice;

- encourage learners to use the knowledge they already possess;

- encourage reflection and meta-cognition;

- link difficult-to-remember items to more meaningful ones;

- encourage visualization—use image representations;

- use verbal memory aids such as mnemonics;

- use mind-mapping techniques;

- use guided-questioning to activate existing schemata and concepts;

- understand that learners may need to make schemata explicit and challenge their assumptions.

- present content in increasing order of complexity;

- revisit topics to strengthen retention.

6.2.3. Lexical Development

Vocabulary items are the building blocks of language. The revival of interest in vocabulary among educational researchers has been motivated by the acknowledgement of the significance of lexical knowledge in language mastery. Words are idiosyncratic components in the language that embrace sets of properties: orthographic, morphological, syntactic, semantic and pragmatic. Besides, words do not only exist in single units; they can also take the form of word combinations that carry a single meaning. Typically, knowledge of words is dichotomized into two primordial dimensions: receptive and productive (expressive). Moreover, Nation (2001, p. 21) emphasized that achieving an adequate mastery of a word both receptively and productively, it is supposed to be conscious of a number of aspects of lexical knowledge: form (spoken, written, and word parts),meaning (form-meaning connection, concepts and referents, associations), and use (grammatical functions, collocations, frequency of occurrence in the language and register). In this regard, the process of acquiring vocabulary is believed to be complex and gradual in nature. It entails incidentally or intentionally creating word-networks stored in the mental lexicon that are enlarged through exposure to language input. Equally, connections between lexical knowledge get stronger of weaker over time depending on a number of factors such as age, frequency of use, the lexica richness of input, cognitive abilities, psychological characteristics of the learner, the L1, the effectiveness of vocabulary learning and teaching strategies. , promoting lexical competence and hence denser lexical networks calls for several measures to endorse. The present study

has revealed a noticeable variance in EFL university students' lexical competence; that is, their abilities to recognize comprehend and use English vocabulary in diverse contexts. In fact, a considerable number of them demonstrated remarkably limited vocabulary repertoires. To point out the highest vocabulary size of receptive knowledge was around (10,200) word families, while research suggested estimated of 15,000 word families for a near-native level and 20,000 level for a university adult. Similarly, using words productively was limited only to high-frequency levels vocabulary. So, given these number, it is fair to state that the obtained results reflect an unsatisfactory mastery of vocabulary that needs to be seriously considered.

The WMC was found to be a determining factor that is highly associated with receptive and productive vocabulary knowledge. Therefore, learners with rich vocabulary believably perform well on WMC tasks that basically measure such abilities as directing attention, manipulating verbal and visual information, task-switching, resisting distractions, and using workable strategies to attain task-relevant goals, which account for the cognitive abilities to allocate WM resources to process, store and retrieve lexical items. Ultimately, we suggest the following pedagogical implications pertinent to fostering vocabulary growth among learners:

- Maximizing reading practices as far as coming across new words in different contexts encourages deeper processing and hence better retention.

- Encouraging learners to infer or make guesses about the meaning(s) of unfamiliar vocabulary using contextual clues, for it requires an in-depth processing and increases the chances of consolidation.

- Paying attention to the morphological constituents of words, their spelling and acoustic features (e.g. stress) to facilitate recognition.

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- Paying attention to words' potential meanings through emphasizing how words are similar or differ in meaning, pointing out words' connotations and denotations, indicating the degree of formality and possible associations, highlighting the semantic relations that tie words in the language such as synonymy and antonymy.

- Raising awareness of the collocability of words such as verb-noun agreement and adjective-nouns pairs. Importantly, collocability is more applicable to large word combinations rather than isolated items.

- Explicitly touching on multi-word units such as idioms, prepositional phrases, phrasal verbs, binomials and trinomials as far as they make a considerable portion of language.

- Using translational equivalents to convey the meanings of particular words (e.g. abstract concepts and low-frequency vocabulary). However, translation should be used with moderation, especially with advanced-learners.

- Taking into account the variance in learning styles among learners; for instance, visual, auditory, and kinesthetic are among the most common preferences. As a result, material of lexical instructions should be diversified accordingly; for example, using visual aids or demonstrations, giving elaborate definitions and contextualized examples of new words, instructing words through performance and involvement of action.

- Fostering learners' autonomy and self-regulatory strategies to take control over their vocabulary learning; for instance, through keeping a systematic record for new vocabulary, using reliable dictionaries resourcefully, drawing on other sources like teachers and more proficient peers.

- Enhancing automaticity in using mnemonic strategies to facilitate the retention and retrieval of lexical items whenever needed; these might include repetitive practice,

rehearsal strategies, keyword technique, using visual mnemonics like diagrams, charts, paraphrasing, and outlines.

- Stressing some grammatical features of words explicitly.

- Encouraging the use of vocabulary in a large diversity of contexts through written and oral productions.

- Providing learners with constant feedback to raise their awareness of the weaknesses that tend to show up in their lexical knowledge.

- Organising instructions in ways that arouse the learners' interest in words as far as motivation is considered as a prerequisite for proficiency in language. As revealed in the questionnaire, for instance, students find the use of technological devices motivational.

- Encouraging risk-taking by engaging students in classroom activities that are communicative in nature such as animated discussion and debates.

Eventually, the increase of vocabulary is not a linear process. It is also affected by a numerous factors that are characteristic to the teacher, learner and instructional practices. As far as the cognitive abilities are concerned in vocabulary enrichment, the goal is to attain an optimal level of utilizing cognitive resources and performance to perfect the learners' abilities to recognize, comprehend and use vocabulary.

6.3. Limitations of the study

In reviewing the present study and its outcomes, some limitations have been recognized throughout the accomplishment of the research work. First, though the sample involved (40) participants who demonstrated significantly fluctuating levels in performance, limitations on the generalizability of the findings to the whole population are identifiable. Second, the absence of laboratories suitable for cognitive psychological experiments such as memory measurement and intelligence tests is another limitation that rendered the task of the

researcher more laborious and time-consuming. The measurement of WMC of every participant was carried out by means of a single computer, while data of vocabulary assessment was collected in print. Third, the time constraints limited the focus of the researcher in both memory and vocabulary testing to a definite number of aspects put under scrutiny. In more appropriate conditions, it would be possible to target a wider range of memory and vocabulary knowledge aspects.

Conclusion

On the basis of the research findings, the present chapter delineated some suggestions and pedagogical implications relevant to the association between the working memory capacity and lexical competence among learners of English as a Foreign Language. Specifically, the application of cognitivists' assumption to language education as well as the implication of the working memory functioning in the learners' abilities to recognize and use words of varying frequency levels in diverse contexts. Noteworthily, the high correlation between measures of performance on working memory capacity tasks and the scores obtained receptive and vocabulary assessment suggest that the enhancement of working memory functioning to manipulate and store information could expand the learners' words webs and hence a better comprehension and production of lexical items. Nonetheless, despite the abundance of findings accumulated in lexical and cognitive research, it is still possible to acquire a deeper understanding of how cognitive faculties underlie the process of language learning.

General Conclusion

The present research is founded on insights and assumptions generated within the fields of educational psychology, cognitive psychology, and neuroscience and language education to achieve an in-depth understanding of the relationship between cognition and language learning. It principally investigates the association between working memory capacity and lexical competence. Against this background, it has been established that English as a Foreign Language learners' performance on WMC tasks strongly correlates with their abilities to recognize, comprehend and use vocabulary.

In the theoretical section of the paper, the first chapter outlines the major learning theories recognized in educational psychology; it concentrates on the views of the cognitive approach about the contribution of various inter-dependent mental processes to the construction and application of knowledge. The second chapter reviews the theoretical frameworks of working memory, assumptions about individual differences in working memory capacity, its measurement and pertinence to scholastic achievement. The third chapter sheds light on descriptions of lexical knowledge, aspects of words knowledge, lexical processing and competence, vocabulary learning and teaching strategies, and paradigms of vocabulary assessment.

The experimental section of the paper embraces the analysis yielded by the analysis of results obtained from the administration of working memory capacity and vocabulary tests as well as the data achieved from the questionnaires delivered to teachers and students. Vocabulary assessment involved two widely used tests: the Vocabulary Size Test, designed to give an estimate of the participants' receptive vocabulary size, the Productive Vocabulary Levels Test, devised to assess the participants' abilities to produce vocabulary in a diversity of contexts. The measurement of working memory capacity deployed two standardized tests: the Reading Span Test was given to measure the participants' working memory capacity to

comprehend, retain and recall words; the SST was administered to give measures of the participants' abilities to retain and retrieve vocabulary in diverse context. The target words used in the four tests were selected on the basis to their frequency of occurrence in the English language according to the BNC. A correlational analysis was eventually carried out to determine the strength of the association between the scores obtained in vocabulary assessment and working memory capacity measurement. As a result, a strong positive correlation has been found between the Vocabulary Size Test scores and Reading Span Test scores; that is, working memory capacity is strongly associated with receptive vocabulary knowledge. Similarly, a strong positive correlation has been achieved between the Productive Vocabulary Levels Test scores and Speaking Span Test scores, which indicates that working memory capacity is strongly associated with productive vocabulary knowledge. Finally, the questionnaires allowed gathering valuable qualitative data that complement the findings of testing. It has been revealed that WM functioning is among the many psychological and cognitive and psychological factors that impact vocabulary processing and use as part of foreign language learners. Moreover, both students and teachers' demonstrated a high level of awareness of role that memory plays to construct lexical knowledge. The analysis of both sorts of data confirm the two hypotheses raised at the beginning of the paper; first, working memory functioning impacts English as a Foreign Language students' lexical competence (vocabulary recognition, comprehension and use); second, variance in working memory capacity is strongly associated with foreign language receptive and productive lexical knowledge.

Finally, some pedagogical implications and recommendations have been suggested. They are basically oriented by the applications of the cognitive approach to education. The section also outlines a set of guidelines to optimize the functioning of WM to meet learning goals. In addition, it delineates a set of instructional procedures that target almost all aspects

of lexical knowledge in the hope that they advance the learners' abilities to process and use lexical items. Consistently, further enquiry into the role of several mental faculties in the process of language learning have been evoked for the purpose of catering for the learners' needs and designing more efficient instruction.

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APPENDICES

Appendix 1: List of the Participants

Number	Full Name	Age	Gender	Level	Number of Years Studying English
1	Subject 1	23	M	M1	12
2	Subject 2	24	M	M1	13
3	Subject 3	22	F	M1	11
4	Subject 4	23	F	M1	12
5	Subject 5	22	F	M1	11
6	Subject 6	23	F	M1	11
7	Subject 7	22	F	M1	11
8	Subject 8	22	F	M1	11
9	Subject 9	22	F	M1	11
10	Subject 10	21	F	M1	11
11	Subject 11	23	F	M1	12
12	Subject 12	23	F	M1	11
13	Subject 13	22	F	M1	11
14	Subject 14	23	F	M1	12
15	Subject 15	22	M	M1	11
16	Subject 16	22	M	M1	11
17	Subject 17	22	F	M1	11
18	Subject 18	22	F	M1	11
19	Subject 19	23	F	M1	12
20	Subject 20	22	F	M1	11
21	Subject 21	23	F	M1	12
22	Subject 22	22	F	M1	11
23	Subject 23	22	F	M1	11
24	Subject 24	23	F	M1	12
25	Subject 25	23	F	M1	11
26	Subject 26	23	F	M1	12
27	Subject 27	22	F	M1	11
28	Subject 28	24	F	M1	12
29	Subject 29	22	F	M1	11
30	Subject 30	22	F	M1	14
31	Subject 31	22	F	M1	11
32	Subject 32	22	F	M1	11
33	Subject 33	22	F	M1	11
34	Subject 34	22	F	M1	11
35	Subject 35	22	F	M1	11
36	Subject 36	22	F	M1	11
37	Subject 37	22	F	M1	11
38	Subject 38	22	F	M1	11
39	Subject 39	23	F	M1	12
40	Subject 40	22	F	M1	11

Appendix 2: The Vocabulary Size Test (VST)

University of Constantine 1   **Date:**…………………...
Faculty of Letters and English Language   **Family Name:**…………
Department of English Language and Letters   **First Name:**……………
                                                   Age:……………………
                                                   Male ( ) Female ( )
                                                   Level: ....

Dear Students,

You are kindly requested to take the following vocabulary test that will serve as a part of a research work undertaken in the Department of Letters and English Language at the University of Constantine in partial fulfillment of the requirements for a Doctorate (LMD) Degree in language sciences.

This proficiency test, the Vocabulary Size Test (VST), is widely used in lexical research; it is designed to measure a person's receptive vocabulary size based on his/her performance on a multiple-choice task. This is the 14000 version containing 140 multiple-choice items, with 10 items from each word family level. The score obtained from such a test is an estimate of one's total receptive vocabulary size.

Please, read the sentences carefully and make the correct choices.

GOOD LUCK

Vocabulary Size Test

Circle the letter a-d with the closest meaning to the key word in the question.

1. SEE: They **saw** it.
   a. cut
   b. waited for
   c. looked at
   d. started

2. TIME: They have a lot of **time**.
   a. money
   b. food
   c. hours
   d. friends

3. PERIOD: It was a difficult **period**.
   a. question
   b. time
   c. thing to do
   d. book

4. FIGURE: Is this the right **figure**?
   a. answer
   b. place
   c. time
   d. number

5. POOR: We are **poor**.
   a. have no money
   b. feel happy
   c. are very interested
   d. do not like to work hard

6. DRIVE: He **drives** fast.
   a. swims
   b. learns
   c. throws balls
   d. uses a car

7. JUMP: She tried to **jump**.
   a. lie on top of the water
   b. get off the ground suddenly
   c. stop the car at the edge of the road
   d. move very fast

8. SHOE: Where is your **shoe**?
   a. the person who looks after you
   b. the thing you keep your money in
   c. the thing you use for writing
   d. the thing you wear on your foot

9. STANDARD: Her **standards** are very high.
   a. the bits at the back under her shoes
   b. the marks she gets in school
   c. the money she asks for
   d. the levels she reaches in everything

10. BASIS: This was used as the **basis**.
    a. answer
    b. place to take a rest
    c. next step
    d. main part

Second 1000

1. MAINTAIN: Can they **maintain** it?
   a. keep it as it is
   b. make it larger
   c. get a better one than it
   d. get it

2. STONE: He sat on a **stone**.
   a. hard thing
   b. kind of chair
   c. soft thing on the floor
   d. part of a tree

3. UPSET: I am **upset**.
   a. tired
   b. famous
   c. rich
   d. unhappy

4. DRAWER: The **drawer** was empty.
   a. sliding box
   b. place where cars are kept
   c. cupboard to keep things cold
   d. animal house

5. PATIENCE: He has no **patience**.
   a. will not wait happily
   b. has no free time
   c. has no faith
   d. does not know what is fair

6. NIL: His mark for that question was **nil**.
   a. very bad
   b. nothing
   c. very good
   d. in the middle

7. PUB: They went to the **pub**.
   a. place where people drink and talk
   b. place that looks after money
   c. large building with many shops
   d. building for swimming

8. CIRCLE: Make a **circle**.
   a. rough picture
   b. space with nothing in it
   c. round shape
   d. large hole

9. MICROPONE: Please use the **microphone**.
   a. machine for making food hot
   b. machine that makes sounds louder
   c. machine that makes things look bigger
   d. small telephone that can be carried around

10. PRO: He's a **pro**.
    a. someone who is employed to find out important secrets
    b. a stupid person
    c. someone who writes for a newspaper
    d. someone who is paid for playing sport etc

Third 1000

1. SOLDIER: He is a **soldier**.
    a.   person in a business
    b.   student
    c.   person who uses metal
    d.   person in the army

2. RESTORE: It has been **restored**.
    a.   said again
    b.   given to a different person
    c.   given a lower price
    d.   made like new again

3. JUG: He was holding a **jug**.
    a.   A container for pouring liquids
    b.   an informal discussion
    c.   A soft cap
    d.   A weapon that explodes

4. SCRUB: He is **scrubbing** it.
    a.   cutting shallow lines into it
    b.   repairing it
    c.   rubbing it hard to clean it
    d.   drawing simple pictures of it

5. DINOSAUR: The children were pretending to be **dinosaurs**.
    a.   robbers who work at sea
    b.   very small creatures with human form but with wings
    c.   large creatures with wings that breathe fire
    d.   animals that lived a long time ago

6. STRAP: He broke the **strap**.
    a.   promise
    b.   top cover
    c.   shallow dish for food
    d.   strip of material for holding things together

7. PAVE: It was **paved**.
    a.   prevented from going through
    b.   divided
    c.   given gold edges
    d.   covered with a hard surface

8. DASH: They **dashed** over it.
    a.   moved quickly
    b.   moved slowly
    c.   fought
    d.   looked quickly

9. ROVE: He couldn't stop **roving**.
    a.   getting drunk
    b.   travelling around
    c.   making a musical sound through closed lips
    d.   working hard

10. LONESOME: He felt **lonesome**.
    a.   ungrateful
    b.   very tired
    c.   lonely
    d.   full of energy

Fourth 1000

1. COMPOUND: They made a new **compound**.
    a.   agreement
    b.   thing made of two or more parts
    c.   group of people forming a business
    d.   guess based on past experience

2. LATTER: I agree with the **latter**.
    a.   man from the church
    b.   reason given
    c.   last one
    d.   answer

3. CANDID: Please be **candid**.
    a.   be careful
    b.   show sympathy
    c.   show fairness to both sides
    d.   say what you really think

4. TUMMY: Look at my **tummy**.
    a.   cloth to cover the head
    b.   stomach
    c.   small furry animal
    d.   thumb

5. QUIZ: We made a **quiz**.
    a.   thing to hold arrows
    b.   serious mistake
    c.   set of questions
    d.   box for birds to make nests in

6. INPUT: We need more **input**.
    a.   information, power, etc. put into something
    b.   workers
    c.   artificial filling for a hole in wood
    d.   money

7. CRAB: Do you like **crabs**?
    a.   sea creatures that walk sideways
    b.   very thin small cakes
    c.   tight, hard collars
    d.   large black insects that sing at night

8. VOCABULARY: You will need more **vocabulary**.
    a.   words
    b.   skill
    c.   money
    d.   guns

9. REMEDY: We found a good **remedy**.
    a.   way to fix a problem
    b.   place to eat in public
    c.   way to prepare food
    d.   rule about numbers

10. ALLEGE: They **alleged** it.
    a.   claimed it without proof
    b.   stole the ideas for it from someone else
    c.   provided facts to prove it
    d.   argued against the facts that supported it

Fifth 1000

1. DEFICIT: The company had a large **deficit**.
    a. spent a lot more money than it earned
    b. went down a lot in value
    c. had a plan for its spending that used a lot of money
    d. had a lot of money in the bank

2. WEEP: He **wept**.
    a. finished his course
    b. cried
    c. died
    d. worried

3. NUN: We saw a **nun**.
    a. long thin creature that lives in the earth
    b. terrible accident
    c. woman following a strict religious life
    d. unexplained bright light in the sky

4. HAUNT: The house is **haunted**.
    a. full of ornaments
    b. rented
    c. empty
    d. full of ghosts

5. COMPOST: We need some **compost**.
    a. strong support
    b. help to feel better
    c. hard stuff made of stones and sand stuck together
    d. rotted plant material

6. CUBE: I need one more **cube**.
    a. sharp thing used for joining things
    b. solid square block
    c. tall cup with no saucer
    d. piece of stiff paper folded in half

7. MINIATURE: It is a **miniature**.
    a. a very small thing of its kind
    b. an instrument to look at small objects
    c. a very small living creature
    d. a small line to join letters in handwriting

8. PEEL: Shall I **peel** it?
    a. let it sit in water for a long time
    b. take the skin off it
    c. make it white
    d. cut it into thin pieces

9. FRACTURE: They found a **fracture**.
    a. break
    b. small piece
    c. short coat
    d. rare jewel

10. BACTERIUM: They didn't find a single **bacterium**.
    a. small living thing causing disease
    b. plant with red or orange flowers
    c. animal that carries water on its back
    d. thing that has been stolen and sold to a shop

Sixth 1000

1. DEVIOUS: Your plans are **devious**.
    a. tricky
    b. well-developed
    c. not well thought out
    d. more expensive than necessary

2. PREMIER: The **premier** spoke for an hour.
    a. person who works in a law court
    b. university teacher
    c. adventurer
    d. head of the government

3. BUTLER: They have a **butler**.
    a. man servant
    b. machine for cutting up trees
    c. private teacher
    d. cool dark room under the house

4. ACCESSORY: They gave us some **accessories**.
    a. papers allowing us to enter a country
    b. official orders
    c. ideas to choose between
    d. extra pieces

5. THRESHOLD: They raised the **threshold**.
    a. flag
    b. point or line where something changes
    c. roof inside a building
    d. cost of borrowing money

6. THESIS: She has completed her **thesis**.
    a. long written report of study carried out for a university degree
    b. talk given by a judge at the end of a trial
    c. first year of employment after becoming a teacher
    d. extended course of hospital treatment

7. STRANGLE: He **strangled** her.
    a. killed her by pressing her throat
    b. gave her all the things she wanted
    c. took her away by force
    d. admired her greatly

8. CAVALIER: He treated her in a **cavalier** manner.
    a. without care
    b. politely
    c. awkwardly
    d. as a brother would

9. MALIGN: His **malign** influence is still felt.
    a. evil
    b. good
    c. very important
    d. secret

10. VEER: The car **veered**.
    a. went suddenly in another direction
    b. moved shakily
    c. made a very loud noise
    d. slid sideways without the wheels turning

Seventh 1000

1. OLIVE: We bought **olives**.
   a. oily fruit
   b. scented pink or red flowers
   c. men's clothes for swimming
   d. tools for digging up weeds

2. QUILT: They made a **quilt**.
   a. statement about who should get their property when they die
   b. firm agreement
   c. thick warm cover for a bed
   d. feather pen

3. STEALTH: They did it by **stealth**.
   a. spending a large amount of money
   b. hurting someone so much that they agreed to their demands
   c. moving secretly with extreme care and quietness
   d. taking no notice of problems they met

4. SHUDDER: The boy **shuddered**.
   a. spoke with a low voice
   b. almost fell
   c. shook
   d. called out loudly

5. BRISTLE: The **bristles** are too hard.
   a. questions
   b. short stiff hairs
   c. folding beds
   d. bottoms of the shoes

6. BLOC: They have joined this **bloc**.
   a. musical group
   b. band of thieves
   c. small group of soldiers who are sent ahead of others
   d. group of countries sharing a purpose

7. DEMOGRAPHY: This book is about **demography**.
   a. the study of patterns of land use
   b. the study of the use of pictures to show facts about numbers
   c. the study of the movement of water
   d. the study of population

8. GIMMICK: That's a good **gimmick**.
   a. thing for standing on to work high above the ground
   b. small thing with pockets to hold money
   c. attention-getting action or thing
   d. clever plan or trick

9. AZALEA: This **azalea** is very pretty.
   a. small tree with many flowers growing in groups
   b. light material made from natural threads
   c. long piece of material worn by women in India
   d. sea shell shaped like a fan

10. YOGHURT: This **yoghurt** is disgusting.
    a. grey mud found at the bottom of rivers
    b. unhealthy, open sore
    c. thick, soured milk, often with sugar and flavouring
    d. large purple fruit with soft flesh

Eighth 1000

1. ERRATIC: He was **erratic**.
   a. without fault
   b. very bad
   c. very polite
   d. unsteady

2. PALETTE: He lost his **palette**.
   a. basket for carrying fish
   b. wish to eat food
   c. young female companion
   d. artist's board for mixing paints

3. NULL: His influence was **null**.
   a. had good results
   b. was unhelpful
   c. had no effect
   d. was long-lasting

4. KINDERGARTEN: This is a good **kindergarten**.
   a. activity that allows you to forget your worries
   b. place of learning for children too young for school
   c. strong, deep bag carried on the back
   d. place where you may borrow books

5. ECLIPSE: There was an **eclipse**.
   a. a strong wind
   b. a loud noise of something hitting the water
   c. The killing of a large number of people
   d. The sun hidden by a planet

6. MARROW: This is the **marrow**.
   a. symbol that brings good luck to a team
   b. Soft centre of a bone
   c. control for guiding a plane
   d. increase in salary

7. LOCUST: There were hundreds of **locusts**.
   a. insects with wings
   b. unpaid helpers
   c. people who do not eat meat
   d. brightly coloured wild flowers

8. AUTHENTIC: It is **authentic**.
   a. real
   b. very noisy
   c. Old
   d. Like a desert

9. CABARET: We saw the **cabaret**.
   a. painting covering a whole wall
   b. song and dance performance
   c. small crawling insect
   d. person who is half fish, half woman

10. MUMBLE: He started to **mumble**.
    a. think deeply
    b. shake uncontrollably
    c. stay further behind the others
    d. speak in an unclear way

Ninth 1000

1. HALLMARK: Does it have a **hallmark**?
   a. stamp to show when to use it by
   b. stamp to show the quality
   c. mark to show it is approved by the royal family
   d. Mark or stain to prevent copying

2. PURITAN: He is a **puritan**.
   a. person who likes attention
   b. person with strict morals
   c. person with a moving home
   d. person who hates spending money

3. MONOLOGUE: Now he has a **monologue**.
   a. single piece of glass to hold over his eye to help him to see better
   b. long turn at talking without being interrupted
   c. position with all the power
   d. picture made by joining letters together in interesting ways

4. WEIR: We looked at the **weir**.
   a. person who behaves strangely
   b. wet, muddy place with water plants
   c. old metal musical instrument played by blowing
   d. thing built across a river to control the water

5. WHIM: He had lots of **whims**.
   a. old gold coins
   b. female horses
   c. strange ideas with no motive
   d. sore red lumps

6. PERTURB: I was **perturbed**.
   a. made to agree
   b. Worried
   c. very puzzled
   d. very wet

7. REGENT: They chose a **regent**.
   a. an irresponsible person
   b. a person to run a meeting for a time
   c. a ruler acting in place of the king
   d. a person to represent them

8. OCTOPUS: They saw an **octopus**.
   a. a large bird that hunts at night
   b. a ship that can go under water
   c. a machine that flies by means of turning blades
   d. a sea creature with eight legs

9. FEN: The story is set in the **fens**.
   a. low land partly covered by water
   b. a piece of high land with few trees
   c. a block of poor-quality houses in a city
   d. a time long ago

10. LINTEL: He painted the **lintel**.
    a. Beam over the top of a door or window
    b. small boat used for getting to land from a big boat
    c. beautiful tree with spreading branches and green fruit
    d. board showing the scene in a theatre

Tenth 1000

1. AWE: They looked at the mountain with **awe**.
   a. worry
   b. interest
   c. wonder
   d. respect

2. PEASANTRY: He did a lot for the **peasantry**.
   a. local people
   b. place of worship
   c. businessmen's club
   d. poor farmers

3. EGALITARIAN: This organization is **egalitarian**.
   a. does not provide much information about itself to the public
   b. dislikes change
   c. frequently asks a court of law for a judgement
   d. treats everyone who works for it as if they are equal

4. MYSTIQUE: He has lost his **mystique**.
   a. his healthy body
   b. the secret way he makes other people think he has special power or skill
   c. the woman who has been his lover while he is married to someone else
   d. the hair on his top lip

5. UPBEAT: I'm feeling really **upbeat** about it.
   a. upset
   b. good
   c. hurt
   d. confused

6. CRANNY: We found it in the **cranny**!
   a. sale of unwanted objects
   b. narrow opening
   c. space for storing things under the roof of a house
   d. large wooden box

7. PIGTAIL: Does she have a **pigtail**?
   a. a rope of hair made by twisting bits together
   b. a lot of cloth hanging behind a dress
   c. a plant with pale pink flowers that hang down in short bunches
   d. a lover

8. CROWBAR: He used a **crowbar**.
   a. heavy iron pole with a curved end
   b. false name
   c. sharp tool for making holes in leather
   d. light metal walking stick

9. RUCK: He got hurt in the **ruck**.
   a. hollow between the stomach and the top of the leg
   b. pushing and shoving
   c. group of players gathered round the ball in some ball games
   d. race across a field of snow

10. LECTERN: He stood at the **lectern**.
    a. desk to hold a book at a height for reading
    b. table or block used for church sacrifices
    c. place where you buy drinks
    d. very edge

Eleventh 1000

1. EXCRETE: This was **excreted** recently.
   a. pushed or sent out
   b. made clear
   c. discovered by a science experiment
   d. put on a list of illegal things

2. MUSSEL: They bought **mussels**.
   a. small glass balls for playing a game
   b. shellfish
   c. large purple fruits
   d. pieces of soft paper to keep the clothes clean when eating

3. YOGA: She has started **yoga**.
   a. handwork done by knotting thread
   b. a form of exercise for body and mind
   c. a game where a cork stuck with feathers is hit between two players
   d. a type of dance from eastern countries

4. COUNTERCLAIM: They made a **counterclaim**.
   a. a demand made by one side in a law case to match the other side's demand
   b. a request for a shop to take back things with faults
   c. An agreement between two companies to exchange work
   d. a top cover for a bed

5. PUMA: They saw a **puma**.
   a. small house made of mud bricks
   b. tree from hot, dry countries
   c. very strong wind that sucks up anything in its path
   d. large wild cat

6. PALLOR: His **pallor** caused them concern.
   a. his unusually high temperature
   b. his lack of interest in anything
   c. his group of friends
   d. the paleness of his skin

7. APERITIF: She had an **aperitif**.
   a. a long chair for lying on with just one place to rest an arm
   b. a private singing teacher
   c. a large hat with tall feathers
   d. a drink taken before a meal

8. HUTCH: Please clean the **hutch**.
   a. thing with metal bars to keep dirt out of water pipes
   b. space in the back of a car for bags
   c. metal piece in the middle of a bicycle wheel
   d. cage for small animals

9. EMIR: We saw the **emir**.
   a. bird with long curved tail feathers
   b. woman who cares for other people's children in Eastern countries
   c. Middle Eastern chief with power in his land
   d. house made from blocks of ice

10. HESSIAN: She bought some **hessian**.
    a. oily pinkish fish
    b. stuff producing a happy state of mind
    c. course cloth
    d. strong-tasting root for flavouring food

Twelfth 1000

1. HAZE: We looked through the **haze**.
   a. small round window in a ship
   b. unclear air
   c. strips of wood or plastic to cover a window
   d. list of names

2. SPLEEN: His **spleen** was damaged.
   a. knee bone
   b. organ found near the stomach
   c. pipe taking waste water from a house
   d. respect for himself

3. SOLILOQUY: That was an excellent **soliloquy**!
   a. song for six people
   b. short clever saying with a deep meaning
   c. entertainment using lights and music
   d. speech in the theatre by a character who is alone

4. REPTILE: She looked at the **reptile**.
   a. old hand-written book
   b. animal with cold blood and a hard outside
   c. person who sells things by knocking on doors
   d. picture made by sticking many small pieces of different colours together

5. ALUM: This contains **alum**.
   a. a poisonous substance from a common plant
   b. a soft material made of artificial threads
   c. a tobacco powder once put in the nose
   d. a chemical compound usually involving aluminium

6. REFECTORY: We met in the **refectory**.
   a. room for eating
   b. office where legal papers can be signed
   c. room for several people to sleep in
   d. room with glass walls for growing plants

7. CAFFEINE: This contains a lot of **caffeine**.
   a. a substance that makes you sleepy
   b. threads from very tough leaves
   c. ideas that are not correct
   d. a substance that makes you excited

8. IMPALE: He nearly got **impaled**.
   a. charged with a serious offence
   b. put in prison
   c. stuck through with a sharp instrument
   d. involved in a dispute

9. COVEN: She is the leader of a **coven**.
   a. a small singing group
   b. a business that is owned by the workers
   c. a secret society
   d. a group of church women who follow a strict religious life

10. TRILL: He practised the **trill**.
    a. ornament in a piece of music
    b. type of stringed instrument
    c. Way of throwing a ball
    d. dance step of turning round very fast on the toes

Thirteenth 1000

1. UBIQUITOUS: Many weeds are **ubiquitous**.
   a. are difficult to get rid of
   b. have long, strong roots
   c. are found in most countries
   d. die away in the winter

2. TALON: Just look at those **talons**!
   a. high points of mountains
   b. sharp hooks on the feet of a hunting bird
   c. heavy metal coats to protect against weapons
   d. people who make fools of themselves without realizing it

3. ROUBLE: He had a lot of **roubles**.
   a. very precious red stones
   b. distant members of his family
   c. Russian money
   d. moral or other difficulties in the mind

4. JOVIAL: He was very **jovial**.
   a. low on the social scale
   b. likely to criticize others
   c. full of fun
   d. friendly

5. COMMUNIQUE: I saw their **communiqué**.
   a. critical report about an organization
   b. garden owned by many members of a community
   c. printed material used for advertising
   d. official announcement

6. PLANKTON: We saw a lot of **plankton**.
   a. poisonous weeds that spread very quickly
   b. very small plants or animals found in water
   c. trees producing hard wood
   d. grey clay that often causes land to slip

7. SKYLARK: We watched a **skylark**.
   a. show with aeroplanes flying in patterns
   b. man-made object going round the earth
   c. person who does funny tricks
   d. small bird that flies high as it sings

8. BEAGLE: He owns two **beagles**.
   a. fast cars with roofs that fold down
   b. large guns that can shoot many people quickly
   c. small dogs with long ears
   d. houses built at holiday places

9. ATOLL: The **atoll** was beautiful.
   a. low island made of coral round a sea-water lake
   b. work of art created by weaving pictures from fine thread
   c. small crown with many precious jewels worn in the evening by women
   d. place where a river flows through a narrow place full of large rocks

10. DIDACTIC: The story is very **didactic**.
    a. tries hard to teach something
    b. is very difficult to believe
    c. deals with exciting actions
    d. is written in a way which makes the reader unsure of the meaning

Fourteenth 1000

1. CANONICAL: These are **canonical** examples.
   a. examples which break the usual rules
   b. examples taken from a religious book
   c. regular and widely accepted examples
   d. examples discovered very recently

2. ATOP: He was **atop** the hill.
   a. at the bottom of
   b. at the top of
   c. on this side of
   d. on the far side of

3. MARSUPIAL: It is a **marsupial**.
   a. an animal with hard feet
   b. a plant that grows for several years
   c. a plant with flowers that turn to face the sun
   d. an animal with a pocket for babies

4. AUGUR: It **augured** well.
   a. promised good things for the future
   b. agreed well with what was expected
   c. had a colour that looked good with something else
   d. rang with a clear, beautiful sound

5. BAWDY: It was very **bawdy**.
   a. unpredictable
   b. enjoyable
   c. rushed
   d. rude

6. GAUCHE: He was **gauche**.
   a. talkative
   b. flexible
   c. awkward
   d. determined

7. THESAURUS: She used a **thesaurus**.
   a. a kind of dictionary
   b. a chemical compound
   c. a special way of speaking
   d. an injection just under the skin

8. ERYTHROCYTE: It is an **erythrocyte**.
   a. a medicine to reduce pain
   b. a red part of the blood
   c. a reddish white metal
   d. a member of the whale family

9. CORDILLERA: They were stopped by the **cordillera**.
   a. a special law
   b. an armed ship
   c. a line of mountains
   d. the eldest son of the king

10. LIMPID: He looked into her **limpid** eyes.
    a. clear
    b. tearful
    c. deep brown
    d. beautiful

Appendix 3: The Vocabulary Size Test Answers

First 1000

1. C.2.C.3.B.4.D.5.A.6.B.7.B. 8.D. 9.D.10.D.

Second 1000

1.A.2.A.3.D.4.A.5.A.6.B.7.A.8.C.9.B.10.D.

Third 1000

1.D.2.D. 3.A. 4.C.5.D.6.D.7.D.8.A.9.B.10.C.

Fourth 1000

1.B.2.C.3.D.4.B.5.C.6.A.7.A.8.A.9.A.10.A.

Fifth 1000

1. A.2.B.3.C.4.D.5.D.6.B.7.A.8.B.9.A.10.A.

Sixth 1000

1. A.2.D.3.A.4.D.5.B.6.A.7.A.8.A.9.A.10.A.

Seventh 1000

1.A.2.C.3.C.4.C.5.D.6.D.7.D.8.C.9. A. 10.C.

Eighth 1000

1.D.2.D.3.C.4.B.5.D.6.B.7.A.8.A.9.B.10.D.

Ninth 1000

1.B.2.B.3.B.4.D.5.C.6.B.7.C.8.D.9.A.10.A.

Tenth 1000

1.C.2.D.3.D.4.B.5.B.6.B.7.A.8.A. 9.C. 10.A.

Eleventh 1000

1.A.2.B.3.B.4.A.5.D.6.D.7.B.8.D.9.C.10.C.

Twelfth 1000

1.B.2.B.3.D.4.B.5.D.6.A.7.D.8.C.9.C.10.A.

Thirteenth 1000

1.C.2.B.3.C.4.C.5.D.6.B.7.D.8.C.9.A.10.A.

Fourteenth 1000

1.C.2.B.3.D.4.A.5.D.6.C.7.A.8.B.9.C.10.A.

Appendix 4: Scores Obtained in the Vocabulary Size Test

Full name	CA	WA	NA	Total size
Subject 1	102	20	18	10200
Subject 2	91	14	35	9100
Subject 3	87	30	23	8700
Subject 4	81	55	4	8100
Subject 5	81	58	1	8100
Subject 6	81	36	23	8100
Subject 7	79	31	30	7900
Subject 8	76	63	1	7600
Subject 9	76	61	3	7600
Subject 10	76	33	31	7600
Subject 11	75	65	0	7500
Subject 12	74	17	49	7400
Subject 13	73	64	3	7300
Subject 14	73	38	29	7300
Subject 15	71	19	50	7100
Subject 16	70	17	53	7000
Subject 17	68	53	19	6800
Subject 18	65	43	32	6500
Subject 19	65	59	16	6500
Subject 20	65	18	57	6500
Subject 21	65	16	59	6500
Subject 22	64	10	66	6400
Subject 23	63	74	3	6300
Subject 24	60	46	34	6000
Subject 25	59	17	64	5900
Subject 26	58	21	61	5800
Subject 27	57	12	71	5700
Subject 28	56	84	0	5600
Subject 29	56	12	72	5600
Subject 30	55	31	54	5500
Subject 31	49	32	59	4900
Subject 32	46	29	65	4600
Subject 33	45	19	76	4500
Subject 34	45	31	64	4500
Subject 35	44	29	67	4400
Subject 36	44	24	72	4400
Subject 37	36	9	95	3600
Subject 38	34	50	56	3400
Subject 39	33	45	62	3300
Subject 40	24	9	107	2400

Appendix 5: Diagram of the Scores Obtained in Vocabulary Size Test

Total size

Appendices
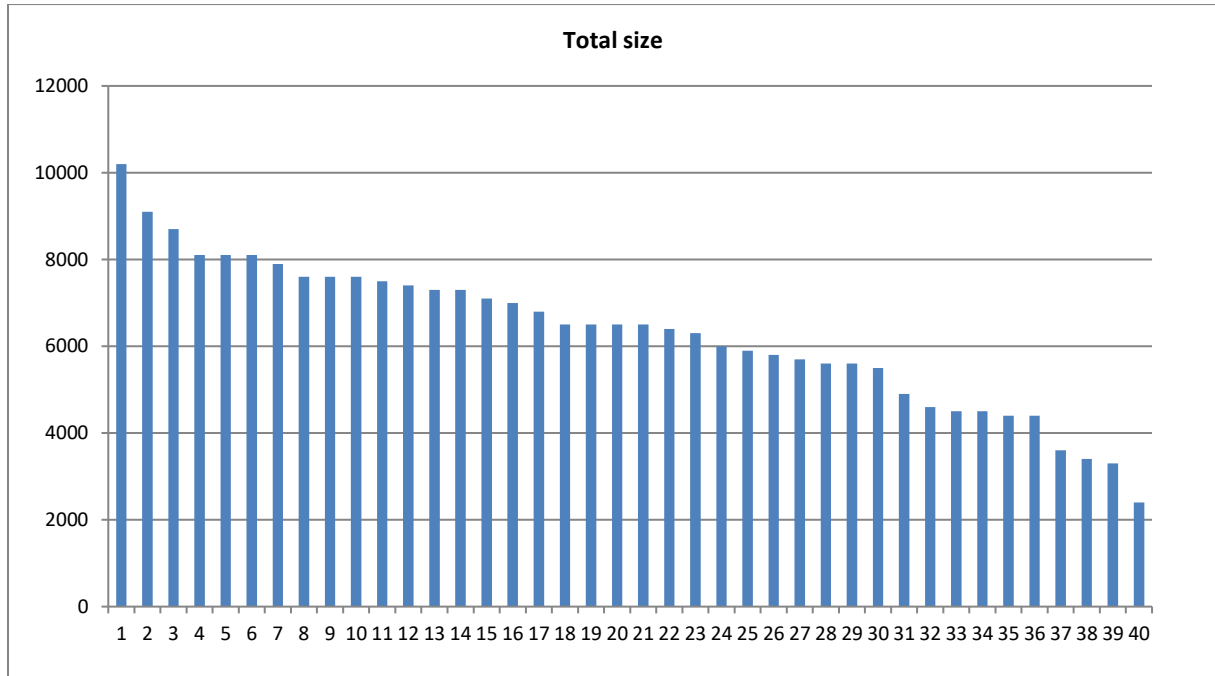
Appendix 6: Table of Percentages of the VST Scores

Full name	CA %	WA%	NA%
Subject 1	73	14,28	12,85
Subject 2	65	10	25
Subject 3	62,14	21,42	16,42
Subject 4	57,85	39,28	2,85
Subject 5	57,85	41,42	0,71
Subject 6	57,85	25,71	16,42
Subject 7	56,42	22,14	21,42
Subject 8	54,28	45	0,71
Subject 9	54,28	43,57	2,14
Subject 10	54,28	23,57	22,14
Subject 11	53,57	46,42	0
Subject 12	52,85	12,14	35
Subject 13	52,14	45,71	2,14
Subject 14	52,14	27,14	20,71
Subject 15	50,71	13,57	35,71
Subject 16	50	12,14	37,85
Subject 17	48,57	37,85	13,57
Subject 18	46,42	30,71	22,85
Subject 19	46,42	42,14	11,42
Subject 20	46,42	12,85	40,71
Subject 21	46,42	11,42	42,14
Subject 22	45,71	7,14	47,14
Subject 23	45	52,85	2,14
Subject 24	42,85	32,85	24,28
Subject 25	42,14	12,14	45,71
Subject 26	41,42	15	43,57
Subject 27	40,71	8,57	50,71
Subject 28	40	60	0
Subject 29	40	8,57	51,42
Subject 30	39,28	22,14	38,57
Subject 31	35	22,85	42,14
Subject 32	32,85	20,71	46,42
Subject 33	32,14	13,57	54,28
Subject 34	32,14	22,14	45,71
Subject 35	31,42	20,71	47,85
Subject 36	31,42	17,14	51,42
Subject 37	25,71	6,42	67,85
Subject 38	24,28	35,71	40
Subject 39	23,57	32,14	44,28
Subject 40	17,14	6,42	76,42

Appendix 7: The Productive Vocabulary Levels Test (PVLT)

University of Constantine 1
Faculty of Letters and English Language
Department of Letters and English

Date:…………………...
Family Name:…………
First Name:……………
Age:…………………….
Male ( ) Female ( )
Level: ....

Dear Students,

      You are kindly requested to take the following vocabulary test that will serve as a part of a research work undertaken in the Department of Letters and English Language at the University of Constantine in partial fulfillment of the requirements for a Doctorate (LMD) Degree in language sciences.

This proficiency test, the Productive Vocabulary Levels Test (PVLT), is widely used in lexical research; it is designed to measure a person's productive lexical knowledge based on his/her performance on a fill-in-the-gap task. It comprises five sections of eighteen sentences, each of which represents a particular word frequency-level.

Please, read the sentences carefully and fill in the gaps. (The initial letters of the missing words are provided).

GOOD LUCK

Section 1: 2000 Level

1. I'm glad we had this opp…… to talk.

2. There are a doz…...eggs in the basket.

3. Every working person must pay income t……

4. The pirates buried the trea………… on a desert island.

5. Her beauty and ch……… had a powerful effect on men.

6. La……. of rain led to a shortage of water in the city.

7. He takes cr………. and sugar in his coffee.

8. The rich man died and left all his we…….. to his son.

9. Pup…… must hand in their papers by the end of the week.

10. This sweater is too tight. It needs to be stre………

11. Ann intro……. her boyfriend to her mother.

12. Teenagers often adm…… and worship pop singers.

13. If you blow up that balloon any more it will bu….

14. In order to be accepted into the university, had to impr…… his grades.

15. The telegram was deli……… two hours after it had been sent.

16. The differences were so sl……… that they went unnoticed.

17. The dress you're wearing is lov…….

18. He wasn't very popu……. when he was a teenager, but he has many friends now.

Section 2: 2000-3000

1. He has a successful car……. as a lawyer.

2. The thieves threw ac……. In his face and made him blind.

3. To Improve the country's economy, the government decided on economic ref…… .

4. Everyone in the fun…….. was dressed in black.

5. The government tried to protect the country's industry by reducing the imp….. of cheap
   goods.

6. European agri…….. ministers failed to break the deadlock over the farm subsides.

7. Parents need to provide their children with firm guid……..

8. You don't have to spend a for…… to give your family tasty, healthy meals.

9. The farmer sells the eggs that his he…… lays.

10. Sudden noises at night sca………. me a lot.

11. France was proc……… a republic in the 18th century.

12. Many people are inj…….. in road accidents every year.

13. Giving up smoking can help red…….. the risk of heart disease.

14. He perc……. a light at the end of the tunnel.

15. Children are not independent. They are att……… to their parents.

16. In English law, a person is presumed inn………. until proved guilty.

17. She has been changing partners often because she cannot have a sta………

    relationship with one person.

18. You must wear a bathing suit on a public beach. You're not allowed to bath na…….

Section 3: 3000-5000 Level

1. Police were told to clear the streets of drug de…….. before the Olumpics.

2. An ear……….. lasting approximately 20 seconds struck the city last night.

3. The workmen cleaned up the me……. before they left.

4. Soldiers who die for their country have made the supreme sac………

5. The kitten is playing with a ball of ya………

6. The thieves have forced an en…….. into the building.

7. The building is heated by a modern heating app………

8. We decided to celebrate New Year's E……. together.

9. The soldier was asked to choose between infantry and cav……..

10. This a complex problem that is difficult to compr………

11. The angry crowd sho…… the prisoner as he was leaving the court.

12. Don't pay attention to this rude remark. Just ig…….. it.

13. The Management held a secret meeting. The issues discussed were not disc…… to the workers.

14. Her speech made a pro……. impact on every one of us.

15. The boss got angry with the secretary and it took a lot of tact to soo……. him.

16. We do not have adeq…….   information to make a decision.

17. She is not a child, but a mat…… woman. She can make her own decisions.

18. The prisoner was put in soli………. confinement.

Section 4: University Word List

1. There has been a recent tr……… among prosperous families toward a smaller number of children.

2. I don't want to miss the final ep……… of that serial.

3. Phil………… examines the meaning of life.

4. According to the communist doc…….   , workers should rule the world.

5. Spending many years together deepened their inti……..

6. He usually read the sports sec…….. of the newspaper first.

7. Because of the doctors' strike, the cli……… is closed today.

8. He was suffering from a tremendous st…….. brought on by overwork.

9. The suspect had both opportunity and mot….. to commit the murder.

10. They insp……. all products before sending them out to stores.

11. A considerable amount of evidence was accu…… during the investigation.

12. In a lecture, the lecturer does most of the talking. In a seminar students are expected to par……… in the discussion.

13. He is irresponsible. You cannot re……… on him for hep.

14. It's impossible to eva……… these results, without knowing about the research methods that were used.

15. He finally att……… a position of power in the company.

16. The money was donated by a local businessman who wished to remain ano……..

17. In a hom…….. class all students are of a similar proficiency.

18. The urge to survive is inh……… in all creatures.

Section 5: 5000-10,000 Level

1. The baby is wet. Her dia………. needs chaning.

2. If your lips are sore, try lip…………., not medicine.

3. Second year university students in the US are called soph…………

4. Her favourite flowers are or………..

5. Three children were taken ho……….. during the bank robbery.

6. The evacu……… of the building saved many lives.

7. For many people, wealth is a prospect of unimaginable felic…….

8. This is an unusual singer with a range of three oct……….

9. The two warring sides called a tr……… to avoid further bloodshed.

10. It is important to nur……… a good relationship.

11. The crowd was disp……… when the police arrived.

12. The dead bodies were mutil……… beyond recognition.

13. The dog crin……. when it saw the snake.

14. The town's drinking water was cont………… with poisonous substances.

15. Pack your suit carefully so that you don't cr………. it.

16. I wouldn't hire him. He is unmotivated and indo……..

17. Computers have made typewriters old-fashioned and ob………..

18. He was arrested for ill……… tradings in drugs.

Appendix 8: Answers to the PVLT

Section 1: 2000 Frequency Levels

1. Opportunity 2. Dozen 3. Taxes 4. Treasure 5. Charm 6. Lack 7. Cream 8. Wealth
9. Pupils 10. Stretched 11. Introduced 12. Admire 13. Burst 14. Improve 15. Delivered
16. Slight 17. Lovely 18. Popular.

Section 2: 2000-3000 Frequency Levels

1. Career 2. Acid 3. Reforms 4. Funeral 5. Import 6. Agriculture 7. Guidance 8. Fortune 9.
Hens 10. Scare 11. Proclaimed 12. Injured 13. Reducing 14. Perceived 15. Attached 16.
Innocent 17. Stable 18. Naked.

Section 3: 3000-5000 Frequency Levels

1. dealers 2. Earthquake 3. Mess 4. Sacrifice 5. Yarn 6. Entrance 7. Apparatus 8. Eve 9.
Cavalry 10. Comprehend 11. Shouted at 13. Ignore 14. Profound 15. Soothe 16. Adequate 17.
Mature 18. Solitary.

Section 4: University Word List

1. Trend 2. Episode 3. Philosophy 4. Doctrine 5. Intimacy 6. Section 7. Clinic 8. Stress 9.
Motive 10. Inspected 11. Accumulated 12. Participate 13. Rely 14. Evaluate 15. Attained 16.
Anonymous 17. Homogeneous 18. Inherited.

Section 5: 5000-10,000 Frequency Levels

1. Diaper 2. Salve 3. Sophomores 4. Orchids 5. Hostages 6. Evacuation 7. Felicity 8. Octaves
9. Treaty 10. Nurture 11. Dispersed 12. Mutilated 13. Cringe 14. Contaminated 15. Creased.
16. Indolent 17. Obsolete 18. Illegal

Appendix 9: Table of the Total Scores and Percentages of PVLT

Full name	PVLT	PVLT %
Subject 1	66	73
Subject 2	67	74
Subject 3	56	62
Subject 4	41	45
Subject 5	47	52
Subject 6	51	56
Subject 7	46	51
Subject 8	48	53
Subject 9	45	50
Subject 10	64	71
Subject 11	50	55
Subject 12	64	71
Subject 13	62	69
Subject 14	61	68
Subject 15	53	59
Subject 16	46	51
Subject 17	54	60
Subject 18	55	61
Subject 19	47	52
Subject 20	55	61
Subject 21	42	46
Subject 22	50	55
Subject 23	26	29
Subject 24	29	32
Subject 25	61	68
Subject 26	24	26
Subject 27	32	35
Subject 28	21	23
Subject 29	36	40
Subject 30	31	34
Subject 31	29	33
Subject 32	33	36
Subject 33	32	35
Subject 34	21	23
Subject 35	28	31
Subject 36	42	46
Subject 37	31	34
Subject 38	25	28
Subject 39	4	4
Subject 40	29	32

Appendix 10: Diagram of Scores and Percentages Obtained in PVLT
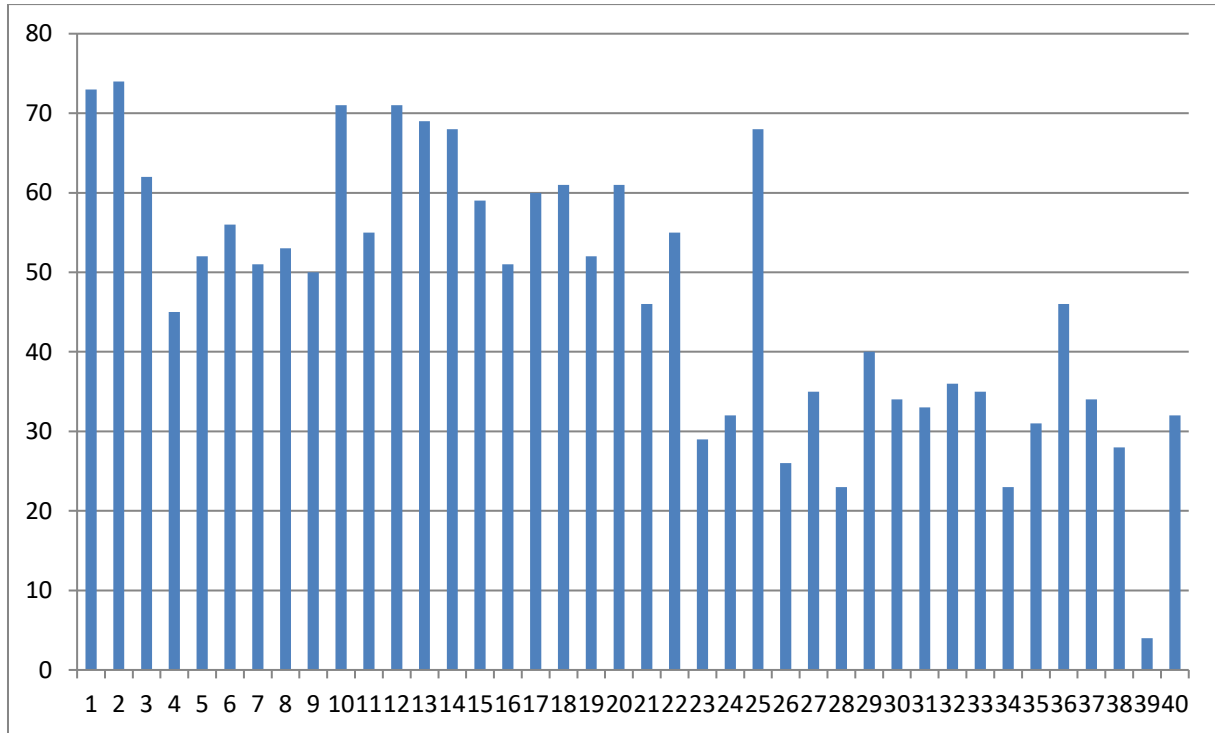
Appendix 11: The Reading Span Test (RST) of WMC

Task: read the sentences demonstrated on the screen aloud and recall the last word in each sentence

Section 1: 20 Sentences

Block 1: Two Sentences

1. "America is a land of freedom and opportunity."

2." In the movie, they take journey backwards through time."

Block 2: Three sentences

1. She walked the horse round in circle.

2. The house retains much of its original charm.

3. The role will be the biggest challenge of his acting career

Block 3: Four Sentences

1.She wanted to enjoy her moment of glory.

2.Many teachers would like to be more adventurous and creative.

3. The country was in the grip of an economic depression.

4. Old people's bones are more prone to fracture.

Block 4: Five Sentences

1. A large part of the work force is employed in agriculture .

2. He caught a faint whiff of her expensive french parfume.

3. We were astonished by how well he performed.

4. I obtained a visa after hours waiting at the embassy.

5. Jones is a talented player but he is very erratic.

Block 5: Six Sentences

1. We resist change because of fear of the unknown.

2. These ideas formed the core of his philosophy.

3. What exactly did you intend by that remark?

4. All major credit cards are accepted in our hotels.

5. People in public life must always be open to criticism .

6. He had no desire to enter the political arena.

Section 2: 20 Sentences

Block 1: Two Sentences

1.I can't see a blessed picture without my glasses.

2.Scientists continue to push back the boundaries of human knowledge.

Block 2: Three Sentences

1. The female must find a warm place to hatch her eggs.

2.The cover photograph of one magazine showed a dying soldier.

3.This should be clear even to the meanest intelligence.

Block 3: Four Sentences

1.When the electricity was cut off we fell back on candles.

2. I wish he would show me a little more sympathy.

3. Coconuts are one of the staple exports of the islands.

4. His recovery is a tribute to the doctors' skill.

Block 4: Five Sentences

1. There were tubs of flowers on the balcony.

2. The dog pushed its wet nose into my palm.

3. She learned to trust her intuitions about other people's motives.

4. She blew her chances by arriving late for the interview.

5. Boil plenty of salted water, then add the spaghetti.

Block 5: Six Sentences

1. Older people should not be treated as second-class citizens.

2. The two pictures are similar although not identical.

3. I have recently acquired a taste for olives.

4. The company's future does not look very hopeful.

5. He looked at first sight like an English tourist.

5. Her face, though sad, still evoked a feel of serenity.

Section 3

Block 1: Two Sentences

1. You stay there with the luggage while I find a cab.

2. She admitted having driven the car without insurance.

Block 2: Three Sentences

1. The sheep bunched together as soon as they saw the dog.

2. I spend a lot of time in Britain but Paris is still my base.

3. The street gangs have become the terror of the neighbourhood.

Block 3: Four Sentences

1. Families will be better off under the new law.

2. I dipped my toe in the river to test the temperature.

3. I would not trust him; he can be very devious.

4. Even the best players have off days occasionally.

Block 4: Five Sentences

1. The BBC is a major patron of the arts.

2. I decorated the salad with a spring of mint.

3. Use music and lighting to create a romantic atmosphere.

4. My time in the library was very productive.

5. The pigs are close cousins of the wild hog.

Block 5: Six Sentences

1. The speech was broadcast via a satellite link.

2. The firm has close ties with an American Corporation.

3. The region produces most of the country's wheat.

4. The characters in this book are purely imaginary.

5. The car is available with black or red trim.

6. His resignation was preceded by weeks of speculation

Appendix 12: Levels of Frequency of words to be recalled in the RST

Section 1: 20 words

Block 1: Two words

1. Opportunity. 2K

2. Time. 2K

Block 2: Three words

1. Circle. 2K

2. Charm. 2K

3. Career. 3K

Block 3: Four words

1. Glory. 3K

2. Creative. 4K

3. Depression. 5K

4. Fracture. 6K

Block 4: Five words

1. Agriculture. 4K

2. Perfume. 5K

3. Performed. 6K

4. Embassy. 7K

5. Erratic. 8K

Block 5: Six words

1. Unknown. 5K

2. Philosophy. 6K

3. Remark. 7K

4. Hotel. 8K

5. Criticism. 9K

6. Arena. 10

Section 2: 20 words

Block 1: Two words

1. Glasses. 2K

2. Knowledge. 2K

Block 2: Three words

1. Eggs. 2K

2. Soldier. 2K

3. Intelligence. 3K

Block 3: Four words

1. Candles. 3K

2. Sympathy. 4K

3. Island. 5K

4. Skill. 6K

Block 4: Five Sentences

1. Balcony. 4K

2. Palm. 5K

3. Motive. 6K

4. Interview. 7K

5. Spaghetti. 8K

Block 5: Six words

1. Citizens. 5K

2. Identical. 6K

3. Olives. 7K

4. Hopeful. 8K

5. Tourist. 9K

5. Serenity. 10K

Section 3: 20 words

Block 1: Two words

1. Cab. 2K

2. Insurance.

Block 2: Three Sentences

1. Dog. 2K

2. Base. 2K

3. Neighborhood. 3K

Block 3: Four Sentences

1. Law. 3K

2. Temperature. 4K

3. Devious. 5K

4. Occasionally. 6K

Block 4: Five Sentences

1. Arts. 4K

2. Mint. 5K

3. Atmosphere. 6K

4. Productive. 7K

5. Hog. 8K

Block 5: Six Sentences

1. Link. 5K

2. Corporation. 6K

3. Wheat. 7K

4. Imaginary. 8K

5. Trim. 9K

6. Speculation. 10K

Appendix 13: Reading Span Test Scoring Sheet

University of Constantine   **Date:**
Department of English   **Student's Name:**…………………………
Age: ……..
N° Years Studying English: ……..

Performance on The Reading Span Task

Section 1

Block 1 (2words)……………………………………………………………………………………

Block 2(3words)……………………………………………………………………………………

Block 3(4words)……………………………………………………………………………………

Block 4(5words)……………………………………………………………………………………

Block 5(6words) …………………………………………………………………………………..

Span:

Section 2

Block 1(2 words) ………………………………………………………………………………….

Block 2(3words) …………………………………………………………………………………...

Block 3(4words) ………………………………………………………………………………….

Block 4(5words) …………………………………………………………………………………

Block 5(6words) ………………………………………………………………………………….

Span

Section 3

Block 1 (2words) ………………………………………………………………………………….

Block 2 (3words) ………………………………………………………………………………….

Block 3 (4words) ………………………………………………………………………………….

Block 4 (5words) ………………………………………………………………………………….

Block 5 (6words)…………………………………………………………………………………

Span

Total N° of words recalled …………**Total Span:**…….
Timing…………………

Appendix 14: Table of Scores and Means Based on the Number of Words Recalled in each Set

Full name	Set 1 (words)	Set 2 (words)	Set 3 (words)	Total (words)	Timing (min.)
Subject 1	16	16	17	49	13
Subject 2	15	20	18	53	10
Subject 3	16	15	15	46	9
Subject 4	12	14	13	39	14
Subject 5	14	13	14	41	12
Subject 6	12	15	16	43	13
Subject 7	16	16	16	48	14
Subject 8	13	13	15	41	13
Subject 9	14	12	13	39	9
Subject 10	13	18	16	47	11
Subject 11	12	12	14	38	9
Subject 12	16	15	16	47	10
Subject 13	14	14	11	39	10
Subject 14	16	16	17	49	13
Subject 15	17	15	17	49	13
Subject 16	16	17	17	50	14
Subject 17	12	14	12	38	9
Subject 18	16	16	16	48	12
Subject 19	14	16	19	49	14
Subject 20	16	17	15	48	12
Subject 21	16	12	12	40	13
Subject 22	11	14	12	37	11
Subject 23	14	11	13	38	12
Subject 24	11	12	11	34	12
Subject 25	13	15	15	43	10
Subject 26	17	15	16	48	15
Subject 27	15	13	10	38	10
Subject 28	13	10	11	34	10
Subject 29	17	13	14	44	13
Subject 30	13	13	11	37	10
Subject 31	13	11	10	34	12
Subject 32	13	10	13	36	10
Subject 33	18	17	15	50	14
Subject 34	12	13	10	35	12
Subject 35	13	12	14	39	8
Subject 36	11	12	12	35	10
Subject 37	11	12	12	35	10
Subject 38	15	12	13	40	12
Subject 39	13	9	11	33	10
Subject 40	10	9	10	29	12

Appendix 15: Table of the RST Spans and Means in each Set

Full name	Span 1	Span 2	Span 3	Total span
Subject 1	0,8	0,8	0,85	0,81666667
Subject 2	0,75	1	0,9	0,88333333
Subject 3	0,8	0,75	0,75	0,76666667
Subject 4	0,6	0,7	0,65	0,65
Subject 5	0,7	0,65	0,7	0,68333333
Subject 6	0,6	0,75	0,8	0,71666667
Subject 7	0,8	0,8	0,8	0,8
Subject 8	0,65	0,65	0,75	0,68333333
Subject 9	0,7	0,6	0,65	0,65
Subject 10	0,65	0,9	0,8	0,78333333
Subject 11	0,6	0,6	0,7	0,63333333
Subject 12	0,8	0,75	0,8	0,78333333
Subject 13	0,7	0,7	0,55	0,65
Subject 14	0,8	0,8	0,85	0,81666667
Subject 15	0,85	0,75	0,85	0,81666667
Subject 16	0,8	0,85	0,85	0,83333333
Subject 17	0,6	0,7	0,6	0,63333333
Subject 18	0,8	0,8	0,8	0,8
Subject 19	0,7	0,8	0,95	0,81666667
Subject 20	0,8	0,85	0,75	0,8
Subject 21	0,8	0,6	0,6	0,66666667
Subject 22	0,55	0,7	0,6	0,61666667
Subject 23	0,7	0,55	0,65	0,63333333
Subject 24	0,55	0,6	0,55	0,56666667
Subject 25	0,65	0,75	0,75	0,71666667
Subject 26	0,85	0,75	0,8	0,8
Subject 27	0,75	0,65	0,5	0,63333333
Subject 28	0,65	0,5	0,55	0,56666667
Subject 29	0,85	0,65	0,7	0,73333333
Subject 30	0,65	0,65	0,55	0,61666667
Subject 31	0,65	0,55	0,5	0,56666667
Subject 32	0,65	0,5	0,65	0,6
Subject 33	0,9	0,85	0,75	0,83333333
Subject 34	0,6	0,65	0,5	0,58333333
Subject 35	0,65	0,6	0,7	0,65
Subject 36	0,55	0,6	0,6	0,58333333
Subject 37	0,55	0,6	0,6	0,58333333
Subject 38	0,75	0,6	0,65	0,66666667
Subject 39	0,65	0,45	0,55	0,55
Subject 40	0,5	0,45	0,5	0,48333333

Appendix 16: Table of the Percentages of RST Scores

Full name	Set 1 %	Set 2%	Set 3 %	Total %
Subject 1	80	80	85	81,6666667
Subject 2	75	100	90	88,3333333
Subject 3	80	75	75	76,6666667
Subject 4	60	70	65	65
Subject 5	70	65	70	68,3333333
Subject 6	60	75	80	71,6666667
Subject 7	80	80	80	80
Subject 8	65	65	75	68,3333333
Subject 9	70	60	65	65
Subject 10	65	90	80	78,3333333
Subject 11	60	60	70	63,3333333
Subject 12	80	75	80	78,3333333
Subject 13	70	70	55	65
Subject 14	80	80	85	81,6666667
Subject 15	85	75	85	81,6666667
Subject 16	80	85	85	83,3333333
Subject 17	60	70	60	63,3333333
Subject 18	80	80	80	80
Subject 19	70	80	95	81,6666667
Subject 20	80	85	75	80
Subject 21	80	60	60	66,6666667
Subject 22	55	70	60	61,6666667
Subject 23	70	55	65	63,3333333
Subject 24	55	60	55	56,6666667
Subject 25	65	75	75	71,6666667
Subject 26	85	75	80	80
Subject 27	75	65	50	63,3333333
Subject 28	65	50	55	56,6666667
Subject 29	85	65	70	73,3333333
Subject 30	65	65	55	61,6666667
Subject 31	65	55	50	56,6666667
Subject 32	65	50	65	60
Subject 33	90	85	75	83,3333333
Subject 34	60	65	50	58,3333333
Subject 35	65	60	70	65
Subject 36	55	60	60	58,3333333
Subject 37	55	60	60	58,3333333
Subject 38	75	60	65	66,6666667
Subject 39	65	45	55	55
Subject 40	50	45	50	48,3333333

Appendix 17: The Speaking Span Test (SST)

Task: Read the words demonstrated on the screen outloud and try to make a grammatically correct sentence for each whenever you are show a blank page.

Set 1: 20 words

Block 1: Two words

1. Opportunity.

2. Time.

Block 2: Three words

1. Circle.

2. Charm.

3. Career.

Block 3: Four words

1. Glory.

2. Creative.

3. Depression.

4. Fracture.

Block 4: Five words

1. Agriculture.

2. Perfume.

3. Performed.

4. Embassy.

5. Erratic.

Block 5: Six words

1. Unknown.

2. Philosophy.

3. Remark.

4. Hotel.

5. Criticism.

6. Arena.

Set 2: 20 words

Block 1: Two words

1. Glasses.

2. Knowledge.

Block 2: Three words

1. Eggs.

2. Soldier.

3. Intelligence.

Block 3: Four words

1. Candles.

2. Sympathy.

3. Island.

4. Skill.

Block 4: Five Sentences

1. Balcony.

2. Palm.

3. Motive.

4. Interview.

5. Spaghetti.

Block 5: Six words

1. Citizens.

2. Identical.

3. Olives.

4. Hopeful.

5. Tourist.

5. Serenity.

Set 3: 20 words

Block 1: Two words

1. Cab.

2. Insurance.

Block 2: Three Sentences

1. Dog.

2. Base.

3. Neighborhood.

Block 3: Four words

1. Law.

2. Temperature.

3. Devious.

4. Occasionally.

Block 4: Five words

1. Arts.

2. Mint.

3. Atmosphere.

4. Productive.

5. Hog.

Block 5: Six Sentences

1. Link.

2. Corporation.

3. Wheat.

4. Imaginary.

5. Trim.

6. Speculation

Appendix 19: Table of Scores and Means Based on the Number of Sentences Produced in each Set

Full name	Set 1 (sentences)	Set 2 (sentences)	Set 3 (sentences)	Total (sentences)	Timing (min.)
Subject 1	16	14	14	44	20
Subject 2	14	18	18	50	20
Subject 3	16	16	15	47	20
Subject 4	12	11	7	30	27
Subject 5	15	14	10	39	25
Subject 6	14	15	11	40	25
Subject 7	13	15	11	39	28
Subject 8	12	11	9	32	30
Subject 9	14	14	10	38	20
Subject 10	15	17	14	46	30
Subject 11	10	10	11	31	25
Subject 12	14	13	15	42	30
Subject 13	15	13	12	40	20
Subject 14	13	13	13	39	28
Subject 15	16	16	14	46	30
Subject 16	18	13	10	41	21
Subject 17	8	9	7	24	23
Subject 18	10	12	7	29	24
Subject 19	11	12	10	33	29
Subject 20	13	14	10	37	20
Subject 21	12	15	12	39	29
Subject 22	14	12	14	40	21
Subject 23	12	11	9	32	27
Subject 24	13	10	7	30	29
Subject 25	11	13	12	36	30
Subject 26	14	14	9	37	30
Subject 27	12	11	8	31	24
Subject 28	9	10	9	38	25
Subject 29	11	11	9	31	30
Subject 30	11	13	7	31	25
Subject 31	13	7	6	26	25
Subject 32	11	8	8	27	20
Subject 33	11	12	11	34	30
Subject 34	11	7	6	24	28
Subject 35	10	10	8	28	20
Subject 36	12	13	10	35	23
Subject 37	10	9	8	27	30
Subject 38	10	9	8	27	28
Subject 39	9	9	6	24	30
Subject 40	8	8	5	21	30

Appendix 20: Table of the SST Spans in each Set

Full name	Span 1	Span 2	Span 3	Total span
Subject 1	0,8	0,7	0,7	0,73333333
Subject 2	0,7	0,9	0,9	0,83333333
Subject 3	0,8	0,8	0,75	0,78333333
Subject 4	0,6	0,55	0,35	0,5
Subject 5	0,75	0,7	0,5	0,65
Subject 6	0,7	0,75	0,55	0,66666667
Subject 7	0,65	0,75	0,55	0,65
Subject 8	0,6	0,55	0,45	0,53333333
Subject 9	0,7	0,7	0,5	0,63333333
Subject 10	0,75	0,85	0,7	0,76666667
Subject 11	0,5	0,5	0,55	0,51666667
Subject 12	0,7	0,65	0,75	0,7
Subject 13	0,75	0,65	0,6	0,66666667
Subject 14	0,65	0,65	0,65	0,65
Subject 15	0,8	0,8	0,7	0,76666667
Subject 16	0,9	0,65	0,5	0,68333333
Subject 17	0,4	0,45	0,35	0,4
Subject 18	0,5	0,6	0,35	0,48333333
Subject 19	0,55	0,6	0,5	0,55
Subject 20	0,65	0,7	0,5	0,61666667
Subject 21	0,6	0,75	0,6	0,65
Subject 22	0,7	0,6	0,7	0,66666667
Subject 23	0,6	0,55	0,45	0,53333333
Subject 24	0,65	0,5	0,35	0,5
Subject 25	0,55	0,65	0,6	0,6
Subject 26	0,7	0,7	0,45	0,61666667
Subject 27	0,6	0,55	0,4	0,51666667
Subject 28	0,45	0,5	0,45	0,63333333
Subject 29	0,55	0,55	0,45	0,51666667
Subject 30	0,55	0,65	0,35	0,51666667
Subject 31	0,65	0,35	0,3	0,43333333
Subject 32	0,55	0,4	0,4	0,45
Subject 33	0,55	0,6	0,55	0,56666667
Subject 34	0,55	0,35	0,3	0,4
Subject 35	0,5	0,5	0,4	0,46666667
Subject 36	0,6	0,65	0,5	0,58333333
Subject 37	0,5	0,45	0,4	0,45
Subject 38	0,5	0,45	0,4	0,45
Subject 39	0,45	0,45	0,3	0,4
Subject 40	0,4	0,4	0,25	0,35

Appendix 21: Table of the Percentages of SST Scores

Full name	Set 1 %	Set 2 %	Set 3 %	Total %
Subject 1	80	70	70	73,3333333
Subject 2	70	90	90	83,3333333
Subject 3	80	80	75	78,3333333
Subject 4	60	55	35	50
Subject 5	75	70	50	65
Subject 6	70	75	55	66,6666667
Subject 7	65	75	55	65
Subject 8	60	55	45	53,3333333
Subject 9	70	70	50	63,3333333
Subject 10	75	85	70	76,6666667
Subject 11	50	50	55	51,6666667
Subject 12	70	65	75	70
Subject 13	75	65	60	66,6666667
Subject 14	65	65	65	65
Subject 15	80	80	70	76,6666667
Subject 16	90	65	50	68,3333333
Subject 17	40	45	35	40
Subject 18	50	60	35	48,3333333
Subject 19	55	60	50	55
Subject 20	65	70	50	61,6666667
Subject 21	60	75	60	65
Subject 22	70	60	70	66,6666667
Subject 23	60	55	45	53,3333333
Subject 24	65	50	35	50
Subject 25	55	65	60	60
Subject 26	70	70	45	61,6666667
Subject 27	60	55	40	51,6666667
Subject 28	45	50	45	63,3333333
Subject 29	55	55	45	51,6666667
Subject 30	55	65	35	51,6666667
Subject 31	65	35	30	43,3333333
Subject 32	55	40	40	45
Subject 33	55	60	55	56,6666667
Subject 34	55	35	30	40
Subject 35	50	50	40	46,6666667
Subject 36	60	65	50	58,3333333
Subject 37	50	45	40	45
Subject 38	50	45	40	45
Subject 39	45	45	30	40
Subject 40	40	40	25	35

Appendix 22: The Teachers' Questionnaire

University of Mentouri Brothers Constantine

Faculty of Letters and Foreign Language

Department of Letters and English

The present paper embraces a series of questions whose answers are expected to serve a comprehensive psychoeducational assessment designed for EFL teachers.

You are hereby kindly requested to fill in the empty space beneath each question with an adequate answer.

Thank you in advance for you favourable consideration and time.

Mr. Yahia ALMI

Department of Letters and English

University Frères Mentouri Constantine 1

Age :

Gender :

Degree :

Nº of Years Teaching

1. **What are the cognitive processes that substantially contribute to the process of foreign language acquisition/learning?**

2. **What sort of psychological factors that would influence the process of foreign language acquisition/learning?**

3. **What types of language learning difficulties are frequently faced by students?**

4. **To what extent does memory affect the language learners' academic achievement and outcomes?**

5. **In what types of language learning tasks is the functioning of memory deemed a primary requisite?**

6. **What types of memory mechanisms are you familiar with?**

7. **How well can students retain the instructional material provided in the classroom?**

8. **Do students face difficulties in memorizing linguistic input? If yes, what sort of it is hard to retain?**

9. **How well can learners retain information performing on several tasks simultaneously (e.g. conversation, listening and taking notes)?**

10. **How do you evaluate learners' attentional level and resistance to distractions during classroom activities?**

11. **How well does the learner recall information that s/he knows whenever asked?**

12. **What strategies do you employ to minimize the overload of the instructional material that you deliver?**

13. **What pedagogical strategies do you rely on to enhance learners' abilities to retain, recall and retrieve information?**

14. Does the performance of learners on tests and exams clearly reveal their cognitive and psychological strengths and weaknesses?

15. Do students have problems with vocabulary acquisition/learning?

16. What aspects of word knowledge (e.g. meaning, use, collocation, level of frequency, etc.) do learners find hard to learn?

17. What signs, you might have observed, indicate that a number of learners have a limited lexical knowledge?

18. What learning strategies do learners frequently depend on to acquire/learn lexical items of the target language?

19. To what extent does learners' memory capacity contribute to their lexical mastery?

20. Do learners encounter difficulties in retaining, retrieving, and recalling lexical items? If yes, in what types of learning tasks do they show up?

21. What instructional procedures do you often use to help students comprehend and use lexical items (i.e. receptively and productively)?

22. Does the performance of learners on tests and exams adequately reveal their strengths and weaknesses in lexical competence?

Appendix 23: The Students' Questionnaire

University of Frères Mentouri Constantine 1

Faculty of Letters and Foreign Languages

Department of Letters and English

The present paper embraces a series of questions whose answers are expected to serve a comprehensive psychoeducational assessment designed for EFL students.

You are hereby kindly requested to fill in the empty space beneath each question with an adequate answer.

Thank you in advance for you favourable consideration and time.

Mr. Yahia ALMI

Department of Letters and English

University Frères Mentouri Constantine 1

Age :

Gender :

group

Nº of Years Studying English

1. What are the cognitive processes that you believe play a significant role in foreign language acquisition/learning?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………..

2. What sort of psychological factors that would influence the process of foreign language acquisition/learning?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………….

3. What type(s) of difficulties do you face when learning the target language?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
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4. Do you see that your ability to memorize information affects your mastery of the target language? How?

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5. How well can you memorize the instructional material provided by the teacher(s)?

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6. Do you find that the instructional material and learning tasks delivered by teachers cognitively overloading?

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7. What type of distractions that you face when studying (e.g. noise)? And how can you adequately resist them?

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8. How well can you perform on two language learning tasks (e.g. Listening and taking notes) simultaneously?

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9. Does your performance on tests and exams clearly reflect your cognitive abilities?

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10. What strategies do you often use to enhance your ability to memorize information?

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11. How do teachers methodologies help you retain and memorize better?

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12. To what extent does your vocabulary knowledge allow you to cope with all language learning tasks and activities?

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13. What aspects of vocabulary knowledge (e.g. form, meaning, collocation, etc) seem to you difficult to learn?

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14. What strategies do you employ to enhance your abilities to recognize and comprehend (through listening and reading) words you encounter in the target language? How effective would they be?

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15. What strategies do you use to enhance your abilities to produce and use (though writing and speech) vocabulary items in target language? And how effective are they?

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16. How does your memory functioning impact your vocabulary knowledge?

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17. To what extent is the linguistic input you receive in the classroom sufficient to promote your vocabulary building?

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18. What instructional strategies do teachers use to expand your vocabulary repertoires? Are they adequately effective?

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19. Are there any other sources you rely on to build up your vocabulary? If yes, what are they?

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Thank you very much indeed

Résumé

Apprendre une connaissance adéquate des mots est une condition préalable à la maîtrise d'une langue. C'est un processus complexe et continu qui recrute plusieurs facultés cognitives, notamment les mécanismes de la mémoire. La mémoire de travail est un model de la mémoire humaine qui joue un rôle essentiel dans le traitement, le maintien, la manipulation et la récupération de l'information. La présente étude vise à examiner l'association entre la capacité de mémoire de travail et la compréhension et utilisation de vocabulaire parmi les étudiants de l'anglais comme langue étrangère basée sur la fréquence de l'occurrence des mots dans la langue. Pour atteindre cet objectif, quatre tests largement utilisés dans les recherches ont été administrés : deux tests de vocabulaire et deux tests de la capacité de mémoire de travail. Les scores obtenus du test de vocabulaire évaluant la capacité des sujets à reconnaître et comprendre les mots - connaissance lexicale réceptive - ont été comparés à leurs scores dans le test de capacité de mémoire de travail qui mesure leur capacité à comprendre et à mémoriser les mots. Les scores obtenus à partir des tests de vocabulaire qui évaluent leur capacité à utiliser des mots - connaissances lexicales productives - ont été comparés aux scores obtenus dans un test de capacité de mémoire de travail mesurant leurs capacités à retenir et à reproduire des mots dans des phrases. De plus, deux questionnaires ont été remis aux enseignants et aux étudiants afin de déterminer leur conscience et leurs perceptions des implications des capacités cognitives et psychologiques dans l'apprentissage des langues, en mettant davantage l'accent sur le lien entre le vocabulaire et la mémoire. Une forte corrélation a été trouvée entre la capacité de mémoire de travail à reconnaître les mots et les connaissances lexicales réceptives. De même, une corrélation élevée a été trouvée entre la capacité de mémoire de travail des étudiants à retenir et à reproduire des mots et leurs connaissances lexicales productives. Les questionnaires ont révélé que les enseignants et les élèves étaient conscients du rôle important des divers processus à la construction du vocabulaire. En outre, le fonctionnement de la mémoire de travail s'est avéré fortement impliqué dans la compréhension et l'utilisation du vocabulaire.

Mots clés : connaissance lexicale receptive, connaissance lexicale productive, frequence des mots, la capacité de mémoire de travail.

ملخص

يعتبر اكتساب معرفة كافية بالمفردات شرطا أساسيا للتمكن من اللغة. اكتساب المفردات عملية معقدة و مستمرة حيث تعتمد على عدد من القدرات المعرفية خصوصا آليات الذاكرة. الذاكرة العاملة نموذج من الذاكرة البشرية و التي تلعب دورا محوريا في معالجة المعلومات و استرجاعها. تهدف هذه الدراسة إلى الاستفسار حول العلاقة التي تربط قدرة الذاكرة العاملة على فهم و استخدام المفردات على أساس مدى مستوى ترددها في اللغة. لتحقيق هذا الهدف تم إجراء أربع اختبارات تستخدم على نطاق واسع من البحوث تتضمن اختباران للمفردات و اختباران لقدرة الذاكرة العاملة. تمت مقارنة الدرجات المتحصل عليها من قبل المشاركين في اختبار المفردات الذي يقيم قدرتهم في التعرف و فهم المفردات الكامنة بالدرجات المتحصل عليها في اختبار الذاكرة الذي يقيس قدراتهم في التعرف و حفظ الكلمات ، تمت كذلك مقارنة الدرجات المتحصل عليها في اختبار المفردات الذي يقيم قدرات استعمال المفردات في مضامين نص مختلفة بالدرجات المتحصل عليها في اختبار الذاكرة الذي يقيس القدرة على حفظ و إعادة استعمال الكلمات في جمل. كما تم توزيع إستبيانين على أساتذة و طلبة لاستنباط مدى تصورهم لتأثير القدرات المعرفية و العوامل النفسية على تعلم اللغة مع التركيز على الربط بين الذاكرة و المفردات. كشفت النتائج على ارتباط عال بين قدرة الذاكرة العاملة على التعرف على الكلمات و حجم المعرفة المعجمية الكامنة ، و بالمثل أظهرت النتائج ارتباط عال بين قدرة الذاكرة العاملة على حفظ و إعادة استخدام المعرفة المعجمية المستعملة. أظهر الاستبيان مستوى إدراك عال لدى الأساتذة و الطلبة بالدور الكبير لعدة عمليات معرفية وعوامل نفسية في بناء المعرفة المعجمية بالأخص دور الذاكرة العاملة في فهم و استعمال المفردات.

الكلمات المفتاحية: المعرفة المعجمية الكامنة، المعرفة المعجمية المستعملة، مستوى تردد الكلمات في اللغة، قدرة الذاكرة العاملة.