Mohamed Khider University of Biskra
Faculty of Letters and Languages
Department of Foreign Languages

MASTER THESIS

Letters and Foreign Languages
English Language
Science of the Language

Submitted and Defended by:
Radja Herzallah

On : Wednesday, 26 June 2019

Investigating the Efficiency of Using Spaced Repetition Technique in Enhancing Long-term Propositional Knowledge Retention: The Case of Master One Students at the Section of English at Mohamed Kheider University of Biskra

---

Board of Examiners :

Mr.	AOUNALI Walid	MCB	University of Biskra	**President**
Mrs.	MOUSSAOUI Nadjet	MAB	University of Biskra	**Examiner**
Dr.	CHELLI Saliha	MCA	University of Biskra	**Supervisor**

Academic Year : **2018/2019**

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

MOHAMMED KHIDER UNIVERSITY – BISKRA

FACULTY OF LETTERS AND FOREIGN LANGUAGE

SECTION OF ENGLISH

Investigating the Efficiency of Using Spaced Repetition Technique in Enhancing Long-term Propositional Knowledge Retention:

The Case of Master One Students at the Section of English in the University of Biskra

Dissertation submitted to the Department of Foreign Languages as a partial fulfilment of the requirements for the Master degree in Science of the Language

Submitted by: **Radja HERZALLAH** Supervised by: **Dr. Saliha CHELLI**

Board of Examiners:

Chair: Mr. Walid AOUNALI	University of Biskra
Supervisor: Dr. Saliha CHELLI	University of Biskra
Examiner: Mrs. Nadjet MOUSSAOUI	University of Biskra

Academic Year: 2018/2019

Declaration

I, Radja Herzallah, do hereby solemnly declare that the work I presented in this dissertation is my own, and has not been submitted before to any other institution or university for a degree.

This work was carried out and completed at Mohamed KHEIDER University of Biskra, Algeria.

Certified:

Miss: Radja Herzallah

Master Student, Section of English

Dedication

I dedicate this work to

the memory of my father, Belkacem, who appreciated knowledge and urged me to gain it

my mother, Meriem, who is the army behind my back

Acknowledgements

I would like first and foremost to thank Allah the Almighty for having given me strength and enlightenment to accomplish this work.

Special gratitude would go to my supervisor **Dr. Saliha CHELLI** for her patience and guidance.

I would also like to thank the board of examiners members, **Mrs. Nadjet MOUSSAOUI** and **Mr. Walid AOUNALI** for their efforts to evaluate this work.

A special gratitude would go to **Dr. Mustafa ALHAMMAMY (Iraq)**, **Mr. Khaled ELOMDA (Egypt)**, **Mr. Sami HADDAD (Algeria)** and **Dr. Mirna ATIEH (Lebanon)** for their time and contribution to accomplish this research study.

Finally, I would like to express my gratitude to all Master one students at Biskra University for their valuable participation in this work and to all the people who helped me to complete it.

Abstract

The retention of what has been learned as knowledge for a long period of time is a challenge for many students. That is, throughout the learning process, students are always prone to forget their learned knowledge due to many causes. Accordingly, the present research aimed at investigating the efficiency of using the spaced repetition technique in enhancing long-term propositional knowledge retention. Moreover, it sought to explore students' awareness of the importance of protecting their learned knowledge from fleeting. This study hypothesized that using spaced repetition technique can help students improve their long-term propositional knowledge retention and that they are not aware of the importance of protecting their learned knowledge. To achieve the intended aims and test the hypotheses, a qualitative research approach was adopted using a case study. To gather data, a semi-structured questionnaire and a semi-structured interview were used as data collection methods. The population of this study was Master One students of English language at Mohamed Kheider University of Biskra, Algeria, which consisted of 283 students. One fifth of this number that is represented by roughly 57 students was taken as a sample. The findings revealed that spaced repetition is a learning technique that helps to a great extent students to reduce forgetting and promote their long-term propositional knowledge retention. In addition to that the majority of the students are not really aware of the importance of protecting their learned knowledge from evanescing since their only goal behind revising and memorizing information is to pass the examinations. Thus, it can be concluded that the research hypotheses previously stated were confirmed. Therefore, students should urge themselves to apply the spaced repetition technique and incorporate it into their learning routine. Furthermore, teachers need to make students exposure to information through spaced revisions using different ways.

Key words: Long-term knowledge retention, propositional knowledge, spaced repetition

List of Abbreviations and Acronyms

e.g. exempli gratia (for example)

et al. et alia (And others)

ibid ibidem (the same previous source)

i.e. id est (In other words)

LTM Long-term Memory

p. page

PI Proactive Interference

RH Research Hypothesis

RI Retroactive Interference

RQ Research Question

s/he she or he

SM Sensory Memory

STM Sort-term Memory

WM Working Memory

& and

List of Figures

List of Tables

Contents

General Introduction

Chapter One: Long-term Propositional Knowledge Retention

Chapter Two: The Spaced Repetition Technique

Chapter Three: Data Analysis and Interpretation

General Introduction

1. Statement of the Problem

Knowledge is decisively the crux of the matter in the learning process. Accordingly, sharing and transmitting knowledge is the first goal behind schooling mission. Apparently, knowledge in any educational context undergoes successive processes which are mainly encoding, storage and retrieval. For learners, retaining knowledge might be difficult than understanding it. In addition, it should be noted that retaining knowledge is conclusive proof of an effective and successful learning process.

We have observed that almost all students at all levels face difficulties in remembering what they have learned as knowledge. In other words, students often experience forgetting as a natural and concomitant phenomenon to learning process due to many causes, such as decay and interference. Moreover, a great number of students learn and memorize information for the sake of passing the examinations in the first place. Consequently, they usually find themselves unable to remember what they learned a few months or years later. As a matter of fact, the learning process in which knowledge has been learned and then forgotten makes no sense.

In educational contexts, students learn and they also forget. Therefore, their knowledge is always subject to be rapidly evanescing. In this respect, the present study suggested the use of spaced repetition as a learning technique to improve students' long-term propositional knowledge retention and minimize forgetting. This technique is based on repeated and spaced reviews of stored knowledge to boost recall in future occasions.

2. Aims of the Study

The present study sought to investigate students' long-term propositional knowledge retention and the use of spaced repetition technique to enhance it. That is, it aimed to provide a clear picture of the issue in order to better understand it.

Specific Objectives:

- To highlight knowledge forgetting as a natural phenomenon.
- To map out a clear conceptual framework to the present issue.
- To increase students' awareness about the importance of protecting their learned knowledge from fleeting.
- To draw students' attention to the use of memory techniques that help improve long-term knowledge retention and encourage them to adapt such techniques.

3. Research Questions

This research was carried out in order to answer the following research questions:

RQ1: Why do students forget what they have learned as knowledge?

RQ2: To what extent are students aware of the importance of protecting their learned knowledge from disappearing after passing the examinations and after their graduation?

RQ3: To what extent can the use of the spaced repetition technique help students to enhance their long-term propositional knowledge retention?

4. Research Hypotheses

Based on the above research questions, we proposed the following research hypotheses:

RH1: We hypothesised that there are different causes behind forgetting learned knowledge.

RH2: We hypothesised that students are not aware of protecting what they have learned as knowledge after passing the examinations and after their graduation.

RH3: We hypothesised that the use of the spaced repetition technique can help learners improve their long-term propositional knowledge retention.

5. Significance of the Study

The present study provided an opportunity for learners to better understand long-term propositional knowledge retention issue. Besides, it aimed at contributing to the enrichment of research about this issue since there is a limited number of sources targeting it. A further contribution of this study was to draw learners' attention to the importance of protecting learned knowledge. In addition, it highlighted the use of memory techniques that help learners reduce forgetting and retain what they have learned for a long period of time.

6. Research Methodology

Since the present study aimed mainly to investigate the use of the spaced repetition technique in enhancing long-term propositional knowledge retention, a qualitative research approach was adopted using a case study as a research design. For the sake of answering the research questions and testing the hypotheses, a semi-structured questionnaire and a semi-structured interview were used as data collection tools.

In order to carry out this study, it was opted for Master One students of English language at Mohamed Kheider University of Biskra, Algeria for the academic year 2018/2019 as a population because they were expected to be more informative about the issue being investigated. The population consisted of 283 students. One fifth of this number that is represented by roughly 57 students was taken as a sample through simple random sampling to carry out this study.

7. Structure of the Dissertation

This dissertation consists of two parts: the theoretical part and the practical one. It is divided into three chapters. The first two chapters attempt to provide an overview of the previous studies that tackled the present issue; whereas, the third chapter is devoted to the field work and data analysis.

Chapter One

This chapter displays a theoretical overview of long-term propositional knowledge retention. First, it elucidates the nature of knowledge, its types and importance. Then, it defines the human memory and its processes as well as presenting its types with some details. In addition, it sheds light on the forgetting phenomenon and the main causes behind it. Finally, this chapter discusses some factors that affect long-term knowledge retention.

Chapter Two

This chapter is devoted to highlight the spaced repetition technique. First, it introduces Ebbinghaus's work underlying this technique as well as explaining his two pioneering discoveries which are the forgetting curve and the spacing effect. Besides, it widely discusses two fundamental concepts related to the spaced repetition which are retention interval and time intervals. Moreover, it displays different ways of implementing this. Finally, this chapter presents learners' belief towards the spaced repetition.

Chapter Three

This chapter is devoted to present a clear description of the research approach and the research design adopted for this study as well as the data collection methods used to gather the necessary data. In addition, it displays a detailed analysis of the obtained data and a discussion of the results. Finally, this chapter presents a synthesis of the findings as well as the conclusions drawn in this research study.

Chapter One

Long-term Propositional Knowledge Retention

Chapter One: Long-term Propositional Knowledge Retention

Introduction

This chapter is an attempt to provide insights into long-term propositional knowledge retention. First, it tries to elucidate the nature of knowledge and its importance as well as the difference between knowledge and information. Besides, the chapter presents some definitions of knowledge and its main types. Moreover, it defines the human memory as the capacity by which knowledge is gained and protected and displays some of its related notions. Furthermore, the memory processes and the different types of memory with some details will be presented. Finally, this chapter also sheds light on the forgetting phenomenon and the main causes behind it as well as discussing some factors that affect long-term knowledge retention.

1.1 Knowledge: Nature and Importance

Knowledge is decisively one of the most important elements in human life. Undoubtedly, it plays an indispensable part in different life situations and domains, such as learning. Accordingly, the notion of knowledge has been the interest of many philosophers and scholars throughout thousands of years in order to clarify its nature (Crane, 2016; Geisler, 2008; Stenmark, 2001). Bolisani and Bratianu (2018) stated that ancient philosophers and scholars such as Plato and Aristotle have first investigated *knowing* as a human procedure and its result *knowledge* within epistemology. It is pertinent at this point to say that, epistemology is a sub-branch of philosophy developed to determine what knowledge is and identify its nature. It is derived from two Greek words: *episteme* which means knowledge and *logos* which means theory (Geisler, 2008).

It is apparent that the importance of knowledge in life lies in our necessity to it in order to facilitate living and makes things within reach. From primitive ages to the digital age, human beings have developed based on knowledge their material and spiritual communities

(Indira Gandhi National Open University [IGNOU], 2017). That is, knowledge is always considered as a medium to live, progress and achieve welfare (Bolisani and Bratianu, 2018). Knowledge has been widely investigated throughout history in an attempt to provide a clear definition to this notion.

1.2 Definitions of Knowledge

Researchers have actively studied knowledge in which their studies yielded a number of definitions that differed according to the field of study. From many definitions provided by scholars, it seems that the definition of the Greek philosopher and mathematician Plato (427- 347 b. c.) of knowledge as 'true, justified belief' is the most famous and cited definition in literature (Crane, 2016). According to Neta and Prichard (cited in Bolisani & Bratianu, 2018), this definition integrates three conditions as follows:

- The truth condition: means what one knows or claims to know must be true. This condition is what differs between opinion and knowledge.
- The belief condition: means one should believe in what s/he knows.
- The justification condition: means one should have a justification about what s/he believes is true.

It is important to say that these conditions according to many philosophers can be applied only to what is called *propositional knowledge* which is not the case; for example, with *procedural knowledge* (Gale, 2006). That is, propositional knowledge is the only type of knowledge one can say that it is true or not, believe it as well as justify it.

Moreover, one of the well-known knowledge definitions is that of the empiricism school of thought that considers knowledge as 'awareness or familiarity gained by experience'. In his article, Biggam (2001) discussed at length the view of empiricists to knowledge which claims that knowledge can be gained only through experience. He saw that this view has

three main flaws: First, if experience is the only way to gain knowledge, this means that we know only what we experience. He supported his claim by saying that ‘‘we could only claim to know that a successful general called Julius Caesar ruled Rome and was assassinated more than two thousands of years ago if and only if we experienced Caesar’s rule and assassination’’ (2001, p. 2). Second, this definition according to Biggam does not distinguish between what is true and what is false. That is, since truthfulness is an essential condition for knowledge, not all experiences people gain can be regarded as knowledge. To back up his claim, Biggam gave the example of plagiarism in the university education as unacceptable and untrue even if some students have committed it. Third, He added that empiricists do not consider that knowledge can also come from reasoning and logical thinking which means in his opinion that knowledge becomes restricted if it is only experienced through our senses.

Another attempt to define knowledge was made by Daniel Bell, the Harvard University Professor of Sociology, who provided a definition which is deemed to be more generic as follows:

> Knowledge is an organized set of statement of fact or ideas, presenting a reasoned judgment or an experimental result, which is transmitted to others through some communication medium in some systematic form. Knowledge consists of new judgments (Research and scholarship) or presentation of older judgments as exemplified in text books, teaching and learning and collected as library and archival material (cited in Sahoo, Pati & Mohanty, 2017, p. 100).

To put it differently, Sahoo et al. (2017) explained Bell’s words considering knowledge as the organized, meaningful and valuable output of the processed information in human minds in different situations. Moreover, Bell’s definition proposed in 1979 could be viewed as a detailed version of the definition provided by Davenport, De Long and Beers (1998) in which they noted that ‘‘Knowledge is information combined with experience, context,

interpretation, and reflection. It is a high-value form of information that is ready to apply to decisions and actions'' (p. 43). It is worth mentioning that in spite of all the attempts to define knowledge, this concept is still confusing, without a clear definition agreed upon by all stakeholders (Bolisani & Bratianu, 2018). However, researchers managed to elucidate the major differences between knowledge and information as the most used term instead of knowledge.

1.3 Difference between Information and Knowledge

People often use knowledge and information terms interchangeably which is not always appropriate to the context. That is, they often misunderstand things when they think that knowledge is always similar to information (Yeager, 2005). To set the boundaries between knowledge and information, some examples are given here to make explicit the difference between the two concepts. To begin with, Troedson (2009) noted that ''information can exist without an owner while knowledge is something that someone has'' (para. 1). In addition, he and many other scholars believe that information is the cornerstone to build knowledge. Whilst, some of them went further to assert that there is no knowledge without information.

Moreover, the Random House Dictionary of the English Language says that ''Information applies to facts told, read, or communicated that may be unorganized and even unrelated…''; whereas, ''Knowledge is an organized body of information, or the comprehension and understanding consequent on having acquired and organized a body of facts…'' (cited in Yeager, 2005, p. 83). To that end, it seems that the major difference between knowledge and information concepts lies in the degree of organization between the elements consisting them.

Furthermore, Liew (2007) distinguished between information and knowledge by adding the element of purpose when he said that ''Information is a message that contains relevant

meaning, implication, or input for decision and/or action. In essence, the purpose of information is to aid in making decisions and/or solving problems or realizing an opportunity'' (p. 5). On the other hand, he considered Knowledge as ''the cognition or recognition (know-what), capacity to act (know-how), and understanding (know-why) that resides or is contained within the mind or in the brain. The purpose of knowledge is to better our lives. In short, the ultimate purpose of knowledge is for value creation'' (p. 5). In other words, we can say that information builds knowledge that enables people to make decisions and solve problems; whereas, having information only is not sufficient to do so.

1.4 Types of Knowledge

Knowledge is divided into different types according to different considerations. Here there are the main types of knowledge stated in the literature. Personal and Public Knowledge and Propositional and Procedural Knowledge.

Personal knowledge (private knowledge) is the knowledge of the person that can be shared only if there is communication between this person and others (IGNOU, 2017). In contrast, public knowledge (social knowledge) is the collective knowledge that is shared by all people in the society (ibid). Personal knowledge can be gained essentially from social knowledge and, in turn, people construct most of their social knowledge from personal knowledge (IGNOU, 2017). Therefore, the absence of means of communication between the person and the members of his/her society makes the knowledge owned only by that person. Rather, sharing knowledge between the members of the society makes it owned by all of them.

Knowledge can also be famously divided into propositional or procedural. Propositional (declarative, descriptive or factual) knowledge is the knowledge that can be expressed in words (Gemma, 2014; Spacey, 2017) i.e., that can be expressed in declarative sentences as

Gemma added. In other words, it is the knowledge that carries the answer of W_h questions except the *how* (Craft, 2018). Besides, this kind of knowledge is the most important to philosophers and to epistemology in general ("Theory of Knowledge," n.d.). By way of illustration, knowing that 'the internal angles of a triangle add up to 180 degrees' (ibid) and that 'Mary, Queen of Scots, was born on 8 December 1542 and she became a queen when she was six days old' are two examples of propositional knowledge.

Conversely, procedural (practical) knowledge is the knowledge that is hard to be expressed in words (Spacey, 2017). Many scholars including McCormick (1997) defined it as ''know how'' (p. 4). To put it differently, it is the knowledge of the process prerequisite to perform a task (Rittle-Johnson and Schneider, 2015). The well-known example given to illustrate this type is how to ride a bicycle. Craft (2018) stated that one may have a difficulty to gain this type of knowledge if it is expressed in words but it is not the case if s/he do or experience it. Since knowledge is crucial in human life, people should retain it from fading in order to use it when needed. To do so, they absolutely require a memory. In this view, it is necessary to examine what is memory and discover how it works.

1.5 Human Memory

Human memory is a magic power that is involved in every aspect of our life in which no one can imagine how it will be without this power. ''It is needed in developing social relationships, mastering cognitive competencies (mental capacities) and solving various problems'' (National Institute of Open Schooling [NIOS], 2013, p. 113). Kensinger and Schacter (2016) proclaimed that memory was known from ancient times; however, it is until 1880's it was studied systematically by the German philosopher Hermann Ebbinghaus who paved the way to further researches on memory when he proved that information retention could be examined in a scientific way.

1.6 Definitions of Memory

A myriad of definitions of the notion of memory have been proposed in different fields. One of these definitions is what Tulving (1985) stated ‘‘memory is the capacity that permits organisms to benefit from their past experiences’’ (p. 385). Moreover, in his book on cognitive psychology, Goldstein (2008) defined Memory as ‘‘the processes involved in retaining, retrieving, and using information about stimuli, images, events, ideas, and skills after the original information is no longer present’’ (p. 136). Additionally, He pointed out that memory is not solely responsible for remembering what happens in the past but also it is used to remember what we want to do in the future—prospective memory, such as when students want to remember items for an examination. It, thus, can be said that memory is the capacity that enables us to do many tasks, such as benefiting from past experiences, planning for the future and using the present information when needed.

1.7 The Information-Processing Model

The discovery of the human memory has passed through different stages until arriving at the concept we know nowadays. At the outset, memory was viewed as a repository that contains all stored information we knew to be later recalled and used (National Council of Educational Research and Training [NCERT], 2016). Afterwards, with the invention of the computer, an assemblance was made between the human memory and the computer in which both are viewed as systems of processing information through three stages: registration, storage and manipulation (ibid). From this assemblance between the human memory and the computer, Atkinson and Shiffrin suggested the first model of memory ‘the Stage Model’ or ‘the Modal Model’ in 1968.

Atkinson and Shiffrin (1968) divided the memory structurally into three constituents: the sensory register (or the sensory store), the short-term store and the long-term store. They

explained that the information received by sensory organs gets in the sensory register then moves to the short-term store then to the long-term store where it locates permanently. This model is displayed in (Figure 1.1) and the process will be tackled in details later on. Figure 1.1 shows the Stage Model proposed by Atkinson and Shiffrin memory model which represents the three memory stores: sensory memory, short-term memory and long-term memory.

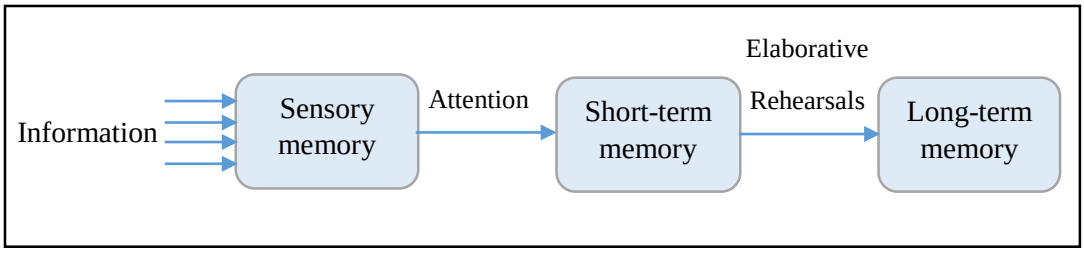

Figure 1.1 Atkinson and Shiffrin memory model (NCERT, 2016, p. 133)

1.8 The Multiple Memory Systems

After proposing the stage model, another memory model which is based on Atkinson and Shiffrin ideas was developed. In explaining the idea of this model, May and Einstein (2013) noted that Atkinson and Shiffrin's model of memory and outcomes from cognitive neuroscience have been merged by scholars who then stated that creating memories demands a set of multiple systems functioning together. Therefore, each type of memory subsystem is related to a specific area in the brain. Regarding this matter, Hsiao and Chai (2003) reported that ''the memory processing can be disrupted with specific brain damage, pathologically or experimentally induced. The disruption is highly selective: certain brain damage interferes with some memories but leaves other memories intact'' (p.169). Therefore, the multiple memory systems model implies that processing information goes through stages in which creating different memories requires many memory systems.

In emphasizing the idea of the multiple systems, May and Einstein (2013) provided many examples as an evidence; for example, noting that people with damage in hippocampal/medial-temporal areas in the brain are unable to create new long-term declarative memories. Rather, they do not find difficulties in creating all types of non declarative memory. In short, this implies that damages in one area in the memory does not mean that all types of memories cannot be created.

1.9 Memory Processes

As mentioned earlier, information undergoes successive processes which are mainly encoding, storage and retrieval. In this view, it is reasonable to assume that understanding the mechanism of memory and how it works requires understanding these three processes. Petersson (2005) suggested that ‘‘the memory trace (i.e., the stored information) can be seen as the resulting changes in the processing system’’ (p. 97). In connection with this, Anderson (2015) pointed out that memory is based on the changeable connections among neurons in the brain or what he called *neural plasticity*. Anderson also regarded two areas in the brain as highly important in human memory. First, the hippocampus which is located in the temporal cortex and related mightily to storing new information. Second, the prefrontal regions which are related to both encoding new information and retrieving old one.

1.9.1 Encoding

Encoding refers to the process through which information from the environment enters the memory system, that is, whenever information is received, encoding happens (Spielman, 2017). Encoding is divided into three types: visual encoding (encoding information that is in form of images), acoustic encoding (encoding information which is in form of sounds) and semantic encoding (encoding of information in terms of its meaning) (ibid). It should be

pointed out that many authors use the term *encoding* to refer to the process of transforming information into long-term memory.

1.9.2 Storage

Storage is the second step that comes after encoding. It refers to the process of keeping information in memory for a period of time, short or long, to be later used (Lally & Valentine-French, 2011). Long-term storage includes a process called consolidation (De la Torre, 2016). This latter was viewed by Cherry (2019) as the process of transmitting information from short-term memory to long-term memory.

1.9.3 Retrieval

Retrieval is the third process that refers to taking the stored information out from memory to the consciousness in order to be used (NCERT, 2016). Tulving (1991) contended that ‘‘the key process of memory is retrieval’’ (p. 91) because, as McDermott and Roediger (2018) explained, successful encoding and storing of information without being able to retrieve it when needed makes no sense.

Information retrieval can take two forms: recall or recognition. First, recall refers to the regeneration of information from memory in which retrieval cues can be used to boost the recall process ("Human Memory," 2012). Second, recognition is the ability to identify formerly learned information when you meet it again; for example, choosing the correct answer in a multiple choice test is subject to the recognition process (Spielman, 2017). In this case, information in itself serves as a cue ("Human Memory," 2012).

1.10 Types of Memory

The differentiation of memory system to subsystems springs from the idea that understanding memory is pertained mainly to comprehending the kind and the function of

information stored in these subsystems (Pishwa, 2006). In this view, the main types of memory system are presented here in terms of both information kind and function.

1.10.1 Sensory Memory

Sensory memory (SM) is the first store in the memory system that includes untreated information (Goddard, 2012). So, it is the beginning of everything when our senses receive stimuli (information) from the environment (De Bruyckere, Kirschner & Hulshof, 2015). Sensory memory has a large capacity but it lasts only for short time (Cowan, 2015; Hall & Stewart, 2010). Moreover, most of researchers including Bernstein and Nash (2008) believe that created memories in SM might disappear fast if we ignore the received stimuli; otherwise, they will be transferred to the short-term memory if we pay attention to those stimuli.

1.10.2 Short-term Memory and Working Memory

Short-term memory (STM) refers to the type of memory that retains restricted pieces of information for roughly 18 seconds (Bernstein & Nash, 2008). Counter to the sensory memory, short-term memory has a restricted capacity (five to nine pieces of information) and lasts for longer time (Kandarakis & Poulos, 2008). Robertson (2002) revealed that STM needs rehearsing; otherwise, stored information in this memory will be lost; for instance, forgetting a telephone number. This information can be retained in what is called working memory (WM) for minutes to hours before it is forgotten if it is not rehearsed, or it can be transferred to long-term memory in which this process depends upon the degree of repetition and usage of this information (ibid).

Bilbrough (2011) differentiated between short-term memory and working memory by noting that ‘‘the concept of working memory, unlike that of short-term memory, implies a state in which things happen, rather than being merely a place …’’ (p. 4). That is, working

memory is the type of memory that is responsible for the mental processing of the information stored in the short-term memory (store) (Bernstein & Nash, 2008) as well as executing cognitive functions, such as transmission to long-term memory and recall from it (Kandarakis & Poulos, 2008).

1.10.3 Long-term Memory

Long-term Memory (LTM) is depicted by Goldstein (2008) as an 'archive' where lived experiences and learned knowledge are stored. In the same vein, Baddeley (2009) viewed LTM as ''a system or systems assumed to underpin the capacity to store information over long periods of time'' (p. 10). In contrast to short-term memory, LTM capacity and duration are unlimited (Bilbrough, 2011). In fact, most of researchers commonly divided LTM into two main types, declarative memory and non declarative memory.

1.10.3.1 Declarative (Explicit) Memory

Declarative memory refers to the type of memory responsible for keeping and retrieving consciously (explicitly) factual knowledge and events (Reber, 2008). This type of memory often debilitates by time (May & Einstein, 2013). Declarative memory can be in turn divided into semantic memory and episodic memory.

Semantic memory is the type of long-term memory related to the retention of propositional (factual knowledge) and terminology meaning (May & Einstein, 2013). In other words, semantic memory includes impersonal and general facts that are not restricted to the time while learning them ("Human Memory," 2012). For instance, storing the fact that Algeria is the tenth largest country in the world or storing the meaning of the word 'manifestation'. In addition to semantic memory, the other type of declarative memory is the episodic memory.

However, episodic (autobiographical) memory is the type of long-term memory related to the past events one experienced in which keeping these memories pertains to the extent of attention given to them (Dharani, 2015). Unlike semantic memory, episodic memory includes personal facts which are organized to some extent in a chronological way ("Human Memory," 2012). For example, remembering your first day in the university or remembering your feeling when you got the baccalaureate degree.

1.10.3.2 Non declarative (Implicit) Memory

Non declarative memory is the kind of memory that is processed unconsciously and used unintentionally (May & Einstein, 2013; Knopf, Graf & Kolling, 2015). As for terminology, Hall (1998) clarified that this type is called ‘non declarative’ because knowledge treated within this memory including knowledge about processes and emotions cannot be expressed (declared) through words. To support his point, Hall gave examples of driving a car and emotional reaction in a frightening situation in which retrieving these memories cannot be happened consciously or expressed in words. One of non declarative memory types is the procedural memory.

Procedural memory refers to the type of memory responsible for performing tasks based on knowledge stored there whether these tasks are physical like swimming and cycling or cognitive to some extent like playing chess (Ten Berge & Van Hezewijk, 1999). Furthermore, procedural Memory is treated unconsciously without thinking (De la Torre, 2006). It should be noted that there are other types of non declarative memory, such as priming and classical conditioning.

1.11 Forgetting

Forgetting is a natural phenomenon that everyone can experience. This phenomenon often makes the process of retaining knowledge a challenge when people find themselves

unable to remember and use what they have learned. Traditionally, forgetting refers to ‘the loss of information over time’ ("Human Memory," 2012). More specifically, ‘‘it is the inability to recall or recognize previously encoded information’’ (Irvington Parents Forum [IPF], 2015, p. 224). Nairne and Pandeirada noted that forgetting is one of the major issues of learning memory that has been researched (cited in Karpicke & Lehman, 2013) in which investigating forgetting issue has been tackled by almost all general psychological textbooks for more than a century (Wixted, 2004). To understand the forgetting phenomenon we need to highlight the causes behind it.

1.12 Main Causes of Forgetting

Forgetting occurs because of many causes. Some of these causes that make people forget in natural circumstances are: decay, interference, motivated forgetting and retrieval failure.

1.12.1 Decay

According to the decay theory, time is the only reason behind forgetting of information (Ryan, 2009). In other words, gradual disappearance of information over time occurs when people do not use this information (ibid). To make the idea simpler, NIOS (2013) likened the decay of memories to the fading of a picture colors because of the sun.

In spite of the fact that decay is the oldest theory about forgetting, it is not credited nowadays by most of psychologists because it is seen as a description of forgetting rather than an explanation ("Human Memory," 2012). Moreover, it was largely disregarded in the early 1900’s when it was discovered that time cannot be the only factor that explains forgetting (Cybenko, 2011). Forgetting due to the passing of time as decay theory claimed is not the only cause stated in literature in which many scholars widely report that forgetting happens because of interfering of information in the memory.

1.12.2 Interference

NIOS (2013) noted that ‘‘whatever we learn, we learn in some context. Thus every experience of learning is preceded and followed by some other experiences. These experiences are often interrelated and influence each other’’ (p. 120). Based on this idea, the explanation of interference theory about forgetting emerged. Interference means that there is a competition during retrieval between a number of memories when they are related to the same cue which results in forgetting (IPF, 2015). For a long time, interference theory was regarded as the most common interpretation for forgetting before it has been criticized and abandoned for many decades then now it emerges again as the most effective interpretation for forgetting, Dewar, Cowan, & Della Sala (cited in Alves & Bueno, 2017). In addition, interference can be proactive or retrospective.

Spielman (2017) pinpointed the two types of interference by stating that ‘‘When old information hinders the recall of newly learned information’’ (p. 274), it is called *proactive interference (PI)* and ‘‘when information learned more recently hinders the recall of older information’’ (p. 274), it is called *retroactive interference (RI)* (see Figure 1.2). Additionally, it is worth noting that the resemblance between the pieces of information acquired highly increases the interference degree between them (NIOS, 2013). Many examples can be given to illustrate these two types. For instance, finding yourself writing the previous year while the new year has already begun is an example of PI (Spielman, 2017); whereas, failing to remember the old password of your e-mail because the new password overlaps with it is an example of RI (IPF, 2015). Figure 1.2 represents how the two types of interference occur.

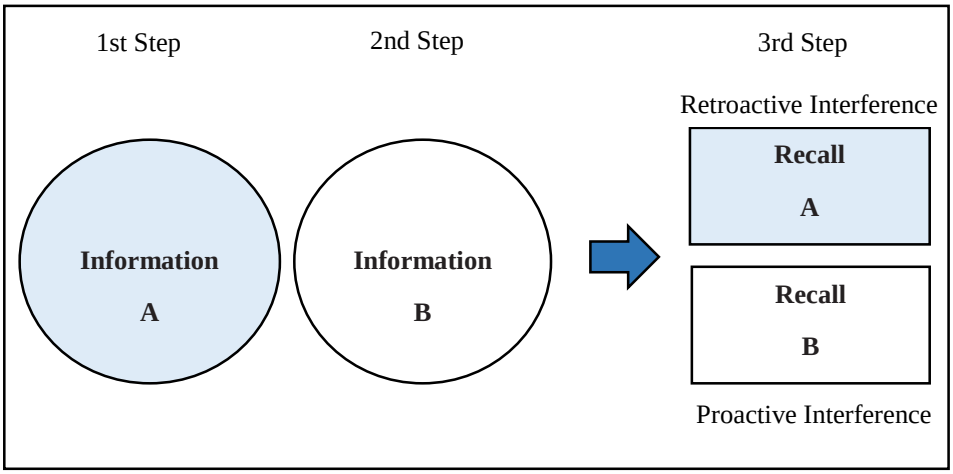

Figure 1.2 Classic paradigms of interference theory (Alves & Bueno, 2017, p. 1058)

1.12.3 Motivated Forgetting

Motivated forgetting may take the form of repression or Zeigarnik effect. In explaining the former, Sigmund Freud claimed that people often do not allow threatening and annoying memories to access to consciousness (Eysenck & Keane, 2015), rather, they thrust these memories into unconsciousness through what Freud called *repression*. The other form of motivated forgetting is *Zeigarnik effec*t which refers to the idea that incomplete tasks seem to be remembered more than complete tasks (NIOS, 2013). In other words, incomplete tasks are difficult to be forgotten because people often feel tense and irritated when they have such tasks that need to be accomplished (Hammadi & Qureishi, 2013). Forgetting can also be related to what is called retrieval cues in which people fail to remember things; for example, when such cues are absent.

1.12.4 Retrieval Failure (Cue-dependent Forgetting)

Tulving and his partners found after many experiments that forgetting can occur also when people cannot access to the information stored in their memories either because the retrieval cues are absent or inappropriate during recall (NCERT, 2016). Moreover, ‘‘our minds/brains do not store exact, verbatim copies of the past. Instead, people use retrieval

cues to try to reconstruct what occurred in the past based on fragmented, imperfect traces of prior experiences'' (Karpicke & Lehman, 2013, para. 11). Here, it is worth noting that retrieval cues are defined as ''stimuli that assist in memory retrieval. In other words, retrieval cues help you access memories stored in long-term memory and bring them to your conscious awareness. The presence of retrieval cues can make recalling memories much easier'' (Williams, n.d. para. 2). Retrieval cues might be a photo, a song, a sound, a smell, a place, a letter, an emotional or physical state and other ("Forgetting," 2012). To sum up, it can be said that retrieval cues are considered as triggers that help to get the information from memory.

Moreover, retrieval is cue dependent in which both external (from the context) and internal (from our internal state) hints and clues help in prompting retrieval (IPF, 2015). An example of external cues is; for example, the smell of an orange when you are peeling it which reminds you of your childhood; whereas, internal cues can be; for instance, your feelings of depression that reminds you of when you missed somebody you love.

1.13 Factors Affecting Long-term Knowledge Retention

As mentioned above, *repetition* in general improves memory and contributes to the transferring of the information from short-term memory to long-term memory. Moreover, Ebbinghaus (1913) pointed out that *attention* and *interest* about the information we receive highly affect the retention and the reproduction of this information later. Therefore, commenting on the factor of repetition, Ebbinghaus asserted that a single repetition of the information is ordinarily not enough even if ample attention is put on it; therefore, a sufficient number of repetitions is needed for successful recall (ibid). There are other factors can also affect long-term knowledge retention. Here we stated the main factors in literature which are: levels of processing, organization, testing effect and distribution of practice.

1.13.1 Levels of Processing

The concept of *level of processing* was first identified by Craik and Lockhart in 1972 when they suggested that the way of processing information differs to be *shallow* (maintenance rehearsal) or *deep* (elaborative rehearsal) (May & Einstein, 2013). Martin, Carlson and Buskist (2010) provided a clear definition of both ways of processing as follow:

> ***Maintenance rehearsal*** is the rote repetition of verbal information – simply repeating an item over and over. This behavior serves to maintain the information in short-term memory but does not necessarily result in lasting changes. In contrast, when people engage in elaborative rehearsal, they think about the information and relate it to what they already know. ***Elaborative rehearsal*** involves more than new information. It involves deeper processing: forming associations, attending to the meaning of the information, thinking about that information, and so on (p. 300).

May & Einstein (2013) proclaimed that shallow processing targets the physical features of the information, such as length, font and color; whereas, deep processing targets the meaning of the information in which it results in best retention as opposed to shallow processing.

1.13.2 Organization

Another factor that many people, especially students, may agree upon its efficiency in retaining knowledge is the organization of the material. Apparently, organizing information by framing it in a certain form may facilitate remembering when the pieces of information are linked together e.g. making ‘trees’ (Goldstein, 2008). Organizing information also provides retrieval cues that help in turn in boosting information retrieval process (NIOS, 2013). In other words, the form of the organized information will act as retrieval cues that help later to recall the information.

1.13.3 Testing Effect (Retrieval Practice)

Many studies had been conducted to examine the effect of tests on memory in which they managed to confirm that effect through several experiments. In this respect, May and Einstein (2013) noted that memory tests has an effect on evaluating our learned knowledge as well as improving our later retention. This effect is termed as *the testing effect* or *test-enhanced learning* and it was first illustrated by Gates in 1917 before it was studied extensively by Carrier and Pasher in 1992 and then by Roediger and Karpicke in 2006 (ibid).

By way of illustration, Carpenter, Pashler and Cepeda (2009) conducted a study on the 8th grade student's retention of U.S. history facts (e.g., who assassinated President *Abraham Lincoln*? Followed by the answer *John Wilkes Booth*). They explored the effect of testing on long-term retention of knowledge and found that students who reviewed the history facts through testing recall are much better in the final test (after nine months) than students who reviewed the history facts through only restudying them. As a result, many studies reported that tests are not just assessment tools, but also a means for future successful retrieval (Carpenter et al., 2009). In addition to testing, distributing the practice of knowledge over time has also proven to be of service in retaining this knowledge for a long period of time.

1.13.4 Distribution of Practice

Distribution of practice refers to the idea that distributing the reviews of information over time yields better results in terms of long-term knowledge retention in contrast to massed practice in which the reviews are massed together without time intervals between them. This factor is discussed at length in the second chapter that tackles the spaced repetition technique.

Conclusion

Knowledge is decisively of immense importance in different aspects of human life, such as learning. This importance springs from its role in helping people progress and bettering their living. Accordingly, gaining and protecting knowledge are two processes that require a mental faculty called memory. It is apparent that retaining knowledge is a challenge that often face people, especially the students because they often forget what they have learned quickly due to many causes. To cope with forgetting, there are many factors that affect long-term knowledge retention learners can draw their attention to in order to promote memorisation and improve their learning.

The next chapter introduces the use of the spaced repetition as a learning technique in enhancing the long-term retention of knowledge.

Chapter Two

The Spaced Repetition Technique

Chapter Two: The Spaced Repetition Technique

Introduction

The present chapter is devoted to highlight one of the learning techniques used to improve long-term knowledge retention and enhance recall called spaced repetition technique. Since this technique traces back to the German psychologist Hermann Ebbinghaus, it was necessary to introduce Ebbinghaus's work underlying this technique as well as explaining his two pioneering discoveries which are the forgetting curve and the spacing effect. This chapter also seeks to explain why this technique is efficient. Moreover, it widely discusses two fundamental concepts related to the spaced repetition which are retention interval and time intervals. Furthermore, different ways of implementing the technique will be displayed. Finally, this chapter presents learners' belief towards the spaced repetition.

2.1 Ebbinghaus's Work

Ebbinghaus's name is probably the most mentioned name in documents related to the human memory study area and learning. The German psychologist Hermann Ebbinghaus was the first who studied memory and forgetting systematically in the late of 1800's (Bernstein & Nash, 2008). While Pavlov and his colleagues shed light on memory encoding by studying the relationship between the bell's sound and food, Ebbinghaus focused on memory retrieval and proved the effectiveness of implementing the spaced practice rather than the massed practice on long-term memory (Kelley & Whatson, 2013). Actually, Ebbinghaus's experiments have enabled him later to be one of the most influential scientists in psychology.

In conducting his research, Ebbinghaus was the researcher and the participant at the same time when he tried to memorize a list of 13 nonsense syllables, such as DAX, LEP, WUJ (Martin et al., 2010). Probably, one wonders about using nonsense syllables in

particular. The answer is that ‘‘Ebbinghaus chose nonsense syllables over words because he did not want meaning to shade his results. He assumed that meaningful stimuli would be more memorable than non-meaningful stimuli…’’ (Schwartz, 2014, p. 6). As a result, Ebbinghaus invented a method called the *method of savings* that enabled him to measure forgetting by making a comparison between the number of attempts allocated to learning the nonsense syllables and the number of attempts allocated to relearning them later (Bernstein & Nash, 2008). For example, ‘‘if it took Ebbinghaus ten trials to learn a list and ten more trials to relearn it, there would be no savings. Forgetting would have been complete. If it took him ten trials to learn the list and only five trials to relearn it, there would be a savings of 50 percent’’ (ibid, p. 228). The systematic way of studying and measuring forgetting leaded Ebbinghaus to draw the well-known curve of forgetting which displays the findings he has reached through his research.

Ebbinghaus method of measuring forgetting was not his only contribution in memory area. He came out with two pioneering discoveries through his research concerning memory and learning (Lally & Valentine-French, 2011). First, he found that forgetting occurs rapidly and dramatically just after learning then it remains constant over time (see Figure 2.1). Second, Ebbinghaus also introduced what is referred to as the *spacing effect* which implies that learning can be better if you distribute what you want to learn over time rather than cram it at once (ibid). These two discoveries were of the main pillars of what was later called the spaced repetition technique.

2.2 Forgetting Curve

As mentioned before, the forgetting curve is one of the discoveries of the German psychologist Hermann Ebbinghaus because of his innovative work on memory. The forgetting curve introduced by Ebbinghaus in 1885 displays that acquired information is

forgotten with the passing of time if it is not reinforced (Hanks & Zhan, 2012) in which learners ordinarily forget rapidly what they learned as knowledge after few days or few weeks if this knowledge is not consciously rehearsed (McNamee, 2018). Accordingly, it is worth noting that roughly 50% of what people newly learned is forgotten within an hour and nearly 70% after 24 hours ("Six ways," 2017). To that end, as time passes, the acquired information is always prone to be forgotten if it is not reviewed.

Commenting on his contribution in psychology, Schwartz (2014) wrote that ''Ebbinghaus is remembered today because he was the first memory psychologist but also because he established a number of principles of memory, which are still relevant today, both in terms of theory and application'' (p. 5). Accordingly, owing to his contribution in psychology as the first psychologist who set the bases of the experimental psychology of memory through his innovative work, the curve of lost learned information is sometimes called the 'Ebbinghaus Forgetting Curve' (Wittman, n.d.). Figure 2.1 shows Ebbinghaus forgetting curve representing the percentage of the retained information and the retention interval that ranges from 20 minutes to 31 days.

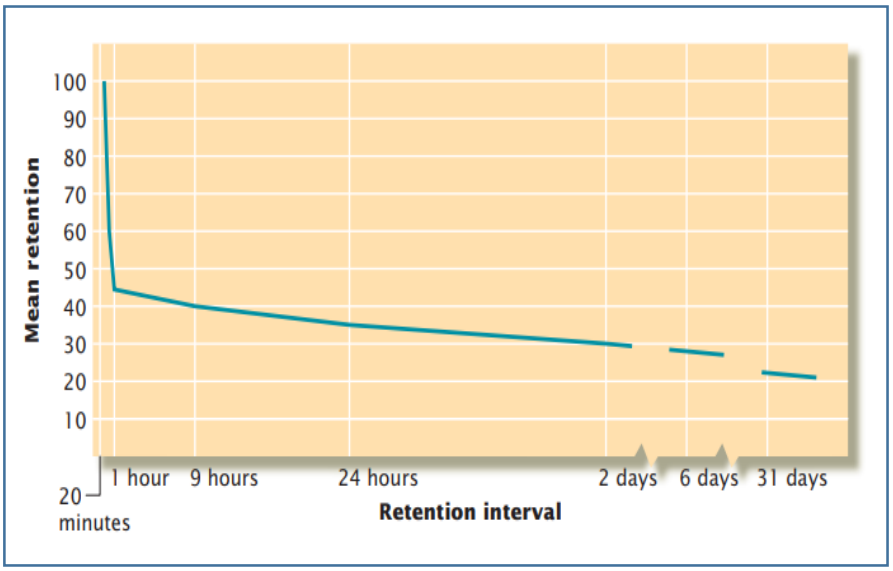

Figure 2.1 Ebbinghaus Forgetting Curve (Bernstein & Nash, 2008, p. 228)

2.3 The Spacing Effect

Ebbinghaus's other discovery was the relation between distribution of learning over time and the retention of learned information or what is referred to as the *spacing effect*. The spacing effect phenomenon has begun before more than 100 years with the work of Ebbinghaus, and it has been tackled by hundreds of studies (Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012; Pashler, Rohrer, Cepeda, & Carpenter, 2007). Spacing effect is also called distributed practice, spaced presentation (De la Rouviere, 2013) or lag effect (Sobel, Cepeda & Kapler, 2011). In an attempt to introduce the concept of spacing effect, Kang (2016) wrote:

> Most people know from personal experience that if one is trying to learn something well—be it a set of facts, concepts, skills, or procedures—a single exposure is usually inadequate for good long-term retention. We are all familiar with the adage "practice makes perfect." But what is less obvious is that the timing of the practice (*when* it occurs) matters a great deal: Having the initial study and subsequent review or practice be spaced out over time generally leads to superior learning than having the repetition(s) occur in close temporal succession (with total study time kept equal in both cases) (p. 13).

To that end, the spacing effect phenomenon explains that the distribution of repetitions over time results in better learning in contrast to massing the repetitions at once time (Gyorbíró, Larkin & Cohen, 2010). Quite in line with this, Goldstein (2008) pointed out that the distributed practice effect can be much better than massed practice because of many reasons including:

- Paying attention to a material for a long time is something hard. Instead,
- Taking breaks between study sessions provides you with better feedback about what you actually know.

Moreover, in attempting to set the difference between spaced practice and massed practice, Carpenter et al. (2012) elucidated that,

> When the spacing gap between two or more presentations of the same item is zero (e.g., the same biology term and definition is presented back-to-back with no interruptions inbetween), the presentations are said to be massed together. When the gap between presentations is greater than zero (e.g., a given biology term is repeated every 5 min or after five different biology terms have been presented), then the presentations are said to be spaced or distributed because they are separated by a nonzero time interval (p. 370).

The procedure of using spaced practice and massed practice is displayed in (Figure 2.2) in which the former refers to that time intervals are incorporated between the reviews followed by a final test; whereas, the latter refers that before having a final test, the reviews are massed together with no time interval between them.

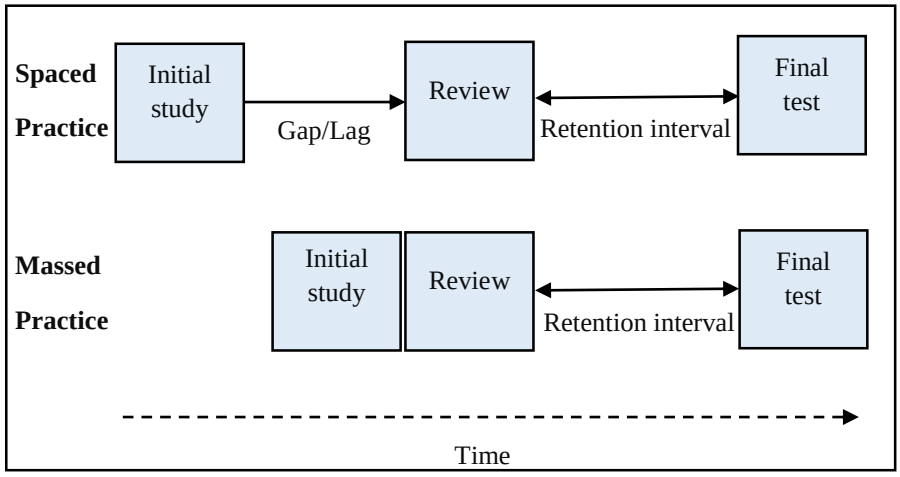

Figure 2.2 The typical experimental procedure for examining the spacing effect (Kang, 2016, p. 13)

The invention of spacing effect by Hermann Ebbinghaus as one of the influential principles in psychology paved the way to many other researchers to further study it from different aspects. The spacing effect has been actively researched in experimental psychology and recently it is integrated into educational settings (Lotfolahi & Salehi, 2016). One of these studies was conducted by Baddeley and Longman in 1978 in order to explore

the effect of the distribution of practice over time (Druckman & Bjork, 1991). To teach post office workers how to type in a short period of time, Baddeley and Longman divided workers into two groups in which some of them spaced their typing practice i.e., one hour per day, whilst the rest of the workers were taught typing through massed practice i.e., four hours per day (ibid). As a result, Baddeley and Longman found that spaced practice resulted in much more effective learning than massed practice (Druckman & Bjork, 1991). At the outset, studies focused mainly on studying the effect of spaced practice by comparing it with massed practice. Thereafter, studies focused on examining the effect of the spaced practice by considering different factors such as the age of learners and the type of knowledge targeted by the spacing effect.

Accordingly, although most of the studies demonstrated the spacing efficiency with adult learners, they also yielded beneficial results with elementary school children, middle school children, and preschool children (Carpenter et al., 2012). Importantly, even though the overwhelming majority of studies conducted to explore the spacing effect were about learning simple information, such as word lists, recent studies have proven that even learning information that is more complicated, such as spelling, reading skills and biology can be fostered by the spacing effect (ibid). On the whole, the spacing effect proved its efficiency in improving memory.

2.4 Memory and Spacing Effect

Improving our memories and finding methods to do so is probably the goal of most of us, especially students. Several forms of learning such as memory and problem solving can be improved through spacing out the reviews or the practice; however, the strongest effect of spacing might be in enhancing memorization of learned knowledge (Kang, 2016). To put it differently, the spacing effect is the phenomenon ‘‘whereby memory is enhanced for the

information that is learned across different points in time rather than being learned at once'' (Lotfolahi & Salehi, 2016, p. 1). In connection with this, a learning technique called *spaced repetition* has been developed based on the phenomenon of spacing effect.

2.5 Spaced Repetition

Since learning is an important aspect in life, finding ways to simplify it and solving the problems that face learners, such as forgetting are always essential goals. Hermann Ebbinghaus was among the psychologists who first studied forgetting and its relationship with time ("Spaced Repetition and MemoryLifter," 2008). He assumed that the amount of acquired information fades increasingly as time passes; however, when it is constantly revised, its fading from memory slows down and decreases with each repetition (Chukharev-Hudilainen & Klepikova, 2016). Accordingly, since creating long-term memories is one of the fundamental tasks in education (Kelley & Whatson, 2013), finding methods to do so was a requirement. One of these methods that were developed to foster learning is the spaced repetition.

More specifically, Spaced repetition technique is a learning method that was first introduced by Cecil Alec Mace in his book entitled 'Psychology of Study' in 1932 (Martínez Sánchez, 2012) as a learning method to gain the benefit of spacing effect proved by Hermann Ebbinghaus (Hanks & Zhan, 2012). Gyorbíró et al. (2010) provided a definition of the spaced repetition which is deemed to be inclusive by saying that ''spaced repetition is a learning technique that reviews learning material at variable intervals of time, ideally just before such information would otherwise be forgotten, to maximize recollection and minimize learning time'' (p. 1).

However, the famous and widely cited definition is the one provided by Baddeley who wrote that the spaced repetition is a learning technique that ''incorporates increasing

intervals of time between subsequent reviews of previously learnt material in order to exploit the psychological spacing effect'' (cited in Yang, Jin, Tao, Xie & Feng, 2016, p. 2). In short, ''spaced repetition is a technique for efficient memorization which uses repeated, spaced review of content to improve long-term retention'' (Tabibian et al., 2018, p. 1). It should be noted here that a few repetitions or many repetitions can be applied (Thalheimer, 2006). In addition, the repetitions of the information cannot necessarily be rote repetitions, rather, they might include paraphrases of the information, exercises, discussions, dialogues and so forth (ibid). In general, one can understand from these definitions that the spaced repetition seeks to repeat the information within increasing time intervals to improve memorization and foster learning.

Spaced repetition has proven its effectiveness over the massed repetition because it uses time intervals between each exposure to the information and another. One may wonder about the scientific explanation of the effect of spacing in the spaced repetition. The answer is that memory consolidation—transferring the information from short-term memory to long-term memory—occurs after making neural connections between the pieces of information that needs time to be made ("Science," 2016). In this respect, Frank (2018) likened the process of acquiring and retaining information to building a brick wall. According to him, heaping bricks above each other without letting the cement between the bricks dry does not lead to building a solid wall, which is the same thing with the pieces of information we acquired. Moreover, the efficiency of spaced repetition lies in incorporating and capturing the most of three psychological phenomena that boost learning and memory (Teninbaum, 2017):

1. The forgetting curve: in which we can anticipate the point in time at which forgetting happens.

2. The spacing effect: which refers to the idea that better remembering of information is achieved when information is reviewed just before the point in time at which we anticipated that forgetting would occur.

3. The testing effect: which implies that testing learners about the acquired information promotes remembering of this information.

As mentioned before, the forgetting curve and the spacing effect were the two discoveries of the German psychologist Hermann Ebbinghaus which are the pillars of the spaced repetition technique. Besides, this technique depends largely on what is called the testing effect which refers to the idea that learners who are tested about what they have learned retain better than learners who are not tested.

2.6 Retention Interval

There are some concepts one cannot build a clear idea about the spaced repetition unless s/he understands them, such as the retention interval. Küpper-Tetzel and Erdfelder (2012) reported that ‘‘the retention interval is the time between the last study episode and the final test’’ (p. 4) (see Figure 2.2). That is, the retention interval refers to the period between the last time the learner revised the information and the time of being tested about it.

Moreover, the retention interval implies the period of time when forgetting of acquired information happens. In connection with this, Farr (1987) stated that generally, if the information is not used for a long time, it will be prone to decay. This result was what Ebbinghaus came out with through his experiment when he used different intervals represented the time between acquiring a list of nonsense syllables and recalling this list (Schwartz, 2014). These intervals varied between few minutes up to 31 days in which he found that a considerable amount of acquired information was lost rapidly at the beginning, especially after one day or two after learning (Martin et al., 2010) (see Figure 2.1). The other

concept that should be discussed to understand the general idea of the spaced repetition technique is the time intervals between revisions sessions. Here there is a detailed discussion about these intervals.

2.7 Time Intervals between Repetitions

Time intervals between study sessions have been extensively investigating since the spacing effect phenomenon was uncovered in the late of 1800's. Apparently, finding the ideal time interval between the repetitions of information is an essential purpose of spaced repetition in which the intervals should be as long as possible and at the same time short to not make the information forgotten (Windarp, 2015). It should be; however, stated that it is challenging to pinpoint the point in time when the information is about to be forgotten and at the same time it is still remembered (Chukharev-Hudilainen & Klepikova, 2016). That is, the very long period of time before reviewing the information might result in forgetting much of what students learned as knowledge (Carpenter et al., 2012). It should be noted that even the spaced repetition incorporates increasing intervals but there are no unified time schedules suited to all cases.

Studies that have explored the difference between expanding schedules and fixed ones came to ambiguous results in which some of the studies have found that expanding schedules are more beneficial than fixed schedules; however, other studies have found that fixed schedules are more beneficial than expanding ones (Carpenter et al., 2012). On the other hand, Karpicke and Bauernschmidt in 2011 found after exploring different spacing schedules (expanding, equal, and contracting), that there is no difference between the schedules in terms of superiority (Chukharev-Hudilainen & Klepikova, 2016). Even though studies came to these conflicting findings, this does not deny the idea that the distribution of revision over time is better than massing it together.

Furthermore, the retention interval was considered as an influential factor that can help to identify how the intervals between the repetitions will be. Cepeda, Vul, Rohrer, Wixted and Pashler (2008) showed that the optimal time interval between study sessions is not an agreed amount, but it depends largely upon the retention interval. That is, the optimal distribution of your study time is pertained to what extent you want to remember something; for example, ‘‘if a person wishes to retain information for several years, a delayed review of at least several months seems likely to produce a highly favorable return on the time investment’’ (ibid, 2008, p. 1101). Similarly, to further explore the effect of the gap between the study sessions on the retention of several types of knowledge, Cepeda et al. (2009) conducted two studies with postponing the test up to six months in which they found as a result that test accuracy increased when the gap between the sessions increased. Thus, the retention interval influences the intervals between the repetitions which in turn influence the accuracy of information recall.

Finding an optimal application of the spaced repetition technique as well as benefiting from time intervals and retention interval are the goals of many studies. In this respect, Cepeda et al. (2008) considered the interactive effects of the gap between study sessions and the retention interval as a challenge for practical application; nevertheless, they asserted that psychologists should provide an accurate application to people in order to enable them to use the time between reviews effectively to enhance long-term retention. Finally, although there is no consensus about how the time intervals between different exposures to the information should be, a great number of scientists believe that long time intervals tend to be better for creating long-term memories than short ones.

2.8 Implementing Spaced Repetition

Along the history of spaced repetition, there were many attempts to propose practical applications of this technique. It worth noting that the most popular application were the two methods invented by Pimsleur and Leitner. With the advent of technology, many software programmes for implementing spaced repetition have emerged.

2.8.1 Pimsleur's Graduated-Interval Recall

In 1967, Paul Pimsleur introduced a spaced repetition system that might be the first practical application of the spaced repetition called *graduated-interval recall* for using it in audio language learning (Settles & Meeder, 2016). He used an expanding time intervals in which after learning new vocabulary, learners review the items after 5 seconds, 25 seconds, 2 minutes, 10 minutes, 1 hour, 5 hours, 1 day, 5 days, 25 days, 4 months, and 2 years using a stopwatch to help them (Teninbaum, 2017). It should be noted that Pimsleur's system is used to review only audio information ("Spaced Repetition," n.d.). In addition to Pimsleur's graduated-interval recall method, there were other methods such as using flashcards which were developed to provide a practical application of the spaced repetition technique.

2.8.2 Physical Flashcards

The use of physical flashcards is the traditional way to practice the spaced repetition in order to better memorization and cope with forgetting. For many years flashcards have been made and used as a helpful tool by both teachers and learners inside and outside the classroom (Farhadi, 2013). At the outset, it is important to know what are flashcards to know how they are used. Farhadi (2013) defined a flashcard as ‘‘a cardboard consisting of a word, a sentence, or a simple picture on it’’ (p. 4). For giving further explanation to the concept of flashcards, (Gyorbíró et al., 2010) stated that,

> Paper or electronic flashcards can be used for memorizing factual knowledge. Each card poses or implies a question on its front, and provides the corresponding answer on its back. During study with flashcards, users choose a number of cards to review, ponder each question, and given the success or failure of each answer, group cards separately for later review (p. 2).

From this explanation, it seems that flashcards enable the learners not only to review the information written on them but also to test themselves about it. The testing effect benefits can be achieved through the use of flashcards in which learners test themselves according to the cue and answer method represented in this case by the two sides of the flashcard (De la Rouviere, 2013). It is worth noting that the first spaced repetition system that used flashcards idea in a systematic way was the Leitner's system.

2.8.2.1 The Leitner's Learning Box System

In his book on memory and learning, the German scientist Sebastian Leitner devised a practical application of the spaced repetition technique ("Spaced Repetition and MemoryLifter," 2008) by proposing in 1972 a system for using flashcards (Settles & Meeder, 2016). Flashcards in Leitner system are generally distributed in five compartments (boxes) in which the information written on the cards moves from the less difficult to the most difficult (Farhadi, 2013). In order to highlight the idea of this system and clarify how it works, Settles and Meeder (2016) explained that,

> The main idea is to have a few boxes that correspond to different practice intervals: 1-day, 2-day, 4-day, and so on. All cards start out in the 1-day box, and if the student can remember an item after one day, it gets "promoted" to the 2-day box. Two days later, if s/he remembers it again, it gets promoted to the 4-day box, etc. Conversely, if s/he is incorrect, the card gets "demoted" to a shorter interval box (p. 1850). See Figure 2.3.

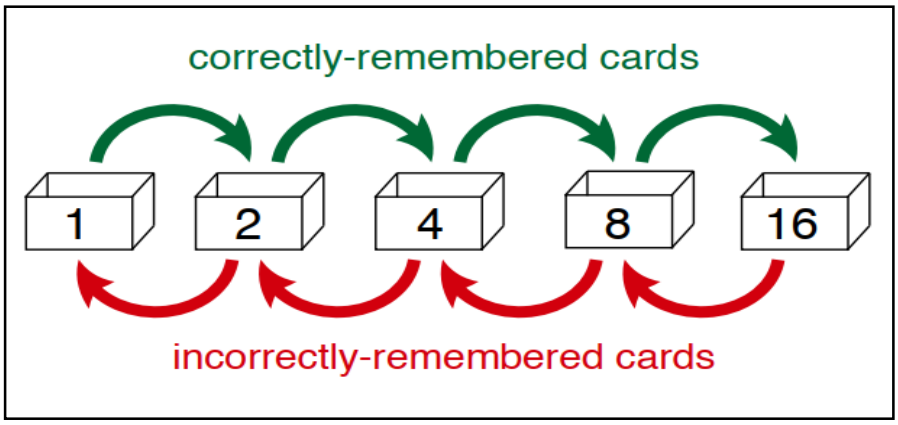

Figure 2.3 The Leitner System for flashcards (Settles & Meeder, 2016, p. 1850)

The Leitner's learning box system for flashcards is the most popular way to implement spaced repetition. In fact, the idea of flashcards boxes in Leitner system is used by several electronic programmes including *Duolingo* for scheduling reviews in which physical boxes are substituted by virtual ones (Settles & Meeder, 2016). Therefore, the simplicity to manipulate the electronic flashcards rather than the physical ones when applying the spaced repetition make them widely used.

2.8.3 Spaced Repetition Software

The use of spaced repetition software became the most useful and popular method of applying this technique. Spaced repetition has proven its effectiveness through the manual use of flashcards technique before digital technologies, such as personal computers and smartphones were invented (Teninbaum, 2017). Nevertheless, Nickson (2017) believed that applying spaced repetition using physical flashcards rather than virtual ones certainly results in losing the paper flashcards or finding difficulties to arrange them in a particular order.

Moreover, it is up to the seventies of the last century, spaced repetition technique was being practiced by using physical flashcards systems which are to some extent impractical because in some cases thousands of cards are required to apply this technique ("Spaced

Repetition," n.d.). Recently, the use of physical flashcards is often substituted by the use of spaced repetition software and online platforms, such as *Mnemosyne*, *Duolingo*, *Synap*, or *SuperMemo* that become day after day widely used (Tabibian et al., 2018). Electronic flashcards do not differ from physical ones; that is, the question is written on the first side and the answer is written on the other side or the word and its translation in the case of acquiring vocabulary (Martínez Sánchez, 2012). As a result, we can say that the principle of using electronic flashcards and physical ones is the same, but the former is more practical and easy to use.

Furthermore, most of electronic flashcards programmes based on spaced repetition are designed by inputting information, such as information in the form of questions and their answers ("Spaced Repetition," n.d.). Afterwards, when the information is reviewed by the learner, the programme displays a question on the screen in which s/he tries to remember the answer (ibid). In both cases success or failure, the learner can reveal the answer by a simple click as well as rate the difficulty that faced him/her during information recall ("Spaced Repetition," n.d.). Although programming the spaced repetition software is often a complicated process that requires experts, using it by learners is quite simple in which it only requires one of the spaced repetition applications and simple clicks.

Nowadays, implementing spaced repetition becomes easier with the advent of several software programmes. For the sake of creating optimal revision schedules, many algorithms have been invented based on the previous experience of the learners with the information they want to acquire (Chukharev-Hudilainen & Klepikova, 2016). In fact, Piotr Wozniak was the first who created in 1982 computer algorithms for spaced repetition (Wozniak, 2014). To do so, Wozniak carried out a myriad of studies that eventually led him to create *SuperMemo* in order to identify optimal intervals between repetitions (Frank, 2018). Determining the time intervals between the repetitions in SuperMemo software is a

complicated process, but some of the first intervals can be simplified as follows: First repetition—1 day, second repetition—7 days, third repetition—16 days, fourth repetition—35 days (ibid). Even though the spaced repetition is an efficient learning technique, most of students do not use it when they want to create long-term memories and retain what they have learned as knowledge.

2.9 Learners and Spaced Repetition

Students often leave what they are supposed to revise to the last minute before the examination. In this case, they find themselves obliged to cram the material in a single study session. Generally, massed practice is better in memorizing information for a short period of time; whereas, in order to retain information for a long period of time, spaced practiced might be the solution (Druckman & Bjork, 1991). Importantly, it should be pointed out that most learners believe that they can perform better if they learn through massed practice rather than spaced practice (Thalheimer, 2006). This false belief often comes from learners' feeling that they master the material if the repetitions are massed together which eventually make them stop revising the material again later on (ibid). There is no denying that although the spaced repetition technique has been considered as one of the effective learning methods, learners are still unaware of its powerful influence in improving memorization and learning.

Conclusion

Learning is one of the fundamental aspects in our life. Apparently, learners are often prone to face difficulties that disrupt their learning process. Accordingly, they tend to use learning techniques to overcome these difficulties including forgetting. One of these techniques is the spaced repetition which is based on the innovative work of the German psychologist Hermann Ebbinghaus. Through his discoveries in psychology, namely the forgetting curve and the spacing effect, Ebbinghaus set the bases of this technique. For

capturing the most of the spaced repetition technique, there are different ways learners can use to implement it for improving their memorization of learned knowledge and underpin the recall.

The next chapter represents the research methodology of this research study as well as displaying the analysis of the data obtained and the final findings.

Chapter Three

Data Analysis and Interpretation

Chapter Three: Data Analysis and Interpretation

Introduction

The current chapter seeks to provide a clear description of the research approach and the research design adopted for this study as well as the data collection methods used to gather the necessary data. In addition, the data obtained from conducting this study that attempts to investigate the use of the spaced repetition technique in enhancing long-term propositional knowledge retention will be displayed with a detailed analysis. Moreover, after accepting or rejecting the hypotheses proposed at the outset of this research study, a discussion of the results will be presented. Finally, this chapter provides a synthesis of the findings as well as the conclusions drawn in this research study.

3.1 Research Approach

The present study aims mainly to investigate the use of the spaced repetition technique in enhancing long-term propositional knowledge retention. It also seeks to highlight knowledge forgetting as a concomitant phenomenon to the learning process. Therefore, the research approach adopted to carry out this study is the qualitative research approach because it serves the nature of this research. Besides, this kind research approach was opted for because it is well suited to answer the research questions and ensure the realization of its aims.

3.2 Research Design

Methodologists believe that the case study design is useful when the research seeks to provide a clear description to understand a certain phenomenon. One of them was Soy (1997) who opined that the case study ‘‘excels at bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research’’ (p. 1). In the same vein, Kumar (2014) stated that ‘‘this design is of immense relevance when the focus of a study is on extensively exploring and understanding

rather than confirming and quantifying'' (p. 155). Accordingly, since the present study aims to understand and describe both learners' long-term propositional knowledge retention and the spaced repetition technique, a case study was used as a research strategy.

3.3 Data Collection Methods

The nature of the research study dictates on the researcher what research approach and research design as well as data collection methods s/he should use. For the sake of accomplishing the present study, a semi-structured questionnaire and a semi-structured interview were used as data collection tools because they are suitable to the nature of this study.

3.3.1 Students' Questionnaire

3.3.1.1 Aim

The students' questionnaire was addressed to Master One students of English language at Biskra University. We designed it to collect information about students' prior experiences with retaining propositional knowledge and forgetting as well as their views towards knowledge retention in general. In addition, this questionnaire sought to know the students' perception towards spaced repetition technique.

3.3.1.2 Structure and Content

This questionnaire included four sections that in turn included a number of questions. Since this questionnaire is semi-structured, the questions were a combination of both close-ended questions and open-ended questions. The first kind of questions (yes/no questions and multiple choice) targeted to collect short and direct answers ;whereas, the second kind of questions targeted to collect longer answers with more details about the present issue through justifying answers and setting the reasons behind them. The questionnaire was designed as follows:

Section One: Students' Prior Experiences with Propositional Knowledge Retention (contains eight items)

This section was designed to explore the students' goal behind memorizing information (item 1) and the type of knowledge they are more likely to remember (item 2). Moreover, the third and the fourth items were devoted to investigate the students' habits concerning materials' revision and the retention period of propositional knowledge, respectively. In addition, this section examined the difficulties students face in recalling knowledge and the reasons behind these difficulties (item 5). Furthermore, it explores the amount of information recalled by the students during the examinations (item 6) and the techniques used to enhance the recall (item 7). The last item was included to discover the students' views towards testing.

Section Two: Students' View towards Knowledge Retention (contains two items)

This section aimed to know students' views towards knowledge retention in general through exploring students' views of the effect of forgetting on learning (item 1) and students' perceptions of the importance of protecting knowledge from fleeting (item 2).

Section Three: Students' Perception towards Spaced Repetition Technique (contains four items)

This section was devoted to probe the students' perception of the spaced repetition technique. The students were asked about their acquaintance with this technique (item 1), the frequency of applying it (item 2) and the way students apply it (item 3). Besides, the final item was included to ask the students about their satisfaction with the efficiency of the spaced repetition technique.

Section Four: Further Suggestions (contains one item)

This section was included to enable the students to provide us with their suggestions about using the spaced repetition technique in enhancing long-term propositional knowledge retention.

3.3.1.3 Data Collection Procedures for the Questionnaire

The questionnaire was distributed to one fifth of Master One English students (57 students) from both divisions: applied linguistics as well as civilization and literature. The distribution of the questionnaire was online via Google Drive application after designing it using Google Forms application. It is worth noting that finding students and checking that they are Master One English students at Biskra University was not an easy task in which it took almost ten days. Furthermore, the results were displayed by using the Microsoft Excel programme.

3.3.1.4 Validation and Piloting

Table 3.1 *Students' questionnaire in the piloting stage*

Structure	Content
Section One	Students' Prior Experiences with Propositional Knowledge Retention (from item 1 to 8)
Section Two	Students' View towards Knowledge Retention (from itm 1 to 2)
Section Three	Students' Perception towards Spaced Repetition Technique (from item 1 to 4)
Section Four	Further Suggestions (1 item)
The Opinionnaire	Items of the opinionnaire from 1 to 7

The piloting stage is an important process in the research where the tools are tried out to avoid any ambiguity or redundancy. Before administering the questionnaire to the

students, it was validated and piloted it in order to come up with a revised version. To do so, the questionnaire was validated by the supervisor of this study who said that no changes are required. Then, it was piloted through distributing it to six students who were chosen randomly from the population. These six students did not take part in answering the final version of the questionnaire. In what follows, the answers of the students and the changes they have recommended were stated.

1. How did you find the questions in general?

When we asked the students about their opinions concerning the questions in general, the majority of the opinions were positive in which the respondents have reported that the questions were inclusive, informative, interesting and easy to answer. However, only one student has opined that the questionnaire was good but a little bit long.

2. Have you noticed that any of the questions seems to be strange or unusual?

The second question in the opinionnaire was about noticing any strange or unusual question (s). Five students have answered that they did not notice any strange or unusual question, while only one student has stated that one of the questions in section four seems to be strange. It should be noted that this question has been omitted from the final version of the questionnaire.

3. Have you found any questions needless or should be omitted?

Regarding this question, all students have reported that they did not find any question that is needless or should be omitted.

4. Have you noted any questions that are unnecessarily repeated in which they targeted the same thing?

Through this question, we sought to know if the students have noted any repeated questions. All students have answered that there is no repetition of questions.

5. Have you detected any mistakes in terms of grammar, spelling, or punctuation?

As for different mistakes, all students agreed that there are no mistakes in terms of grammar, spelling or punctuation.

6. What do you think of the order of questions?

This question was asked to check if the questions were well ordered. The large majority of respondents have stated that the questions were clearly ordered in which five of them have found that the order was logical and the questions move smoothly and gradually from general to specific; whereas, only one student has said that there was a kind of jumping in the questions.

7. If you have any suggestions to help us improve this questionnaire in terms of introduction and questions, please write them down below

Through this question, we asked the respondents to write down any suggestions that enable us to improve the questionnaire. Only one student has suggested to explain more the spaced repetition technique stated in the questionnaire's introduction. This suggestion was taken into consideration in which we have reformulated the technique definition to make it simpler and easy to understand.

3.3.2 Memory Trainers' Interview

3.3.2.1 Aim

This interview was addressed to memory trainers from different countries. It was designed to collect more information about the current issue centering our sights on exploring the spaced repetition technique suggested in this research study.

3.3.2.2 Structure and Content

This interview included initially nine main questions which were prepared in advance. Since this interview is semi-structured, the questions were half prepared. To draw more information from the interviewees, we asked them other related question depending on their answers to the main questions. That is, we started with open-ended questions and then spontaneously more new questions were generated based on the response of the interviewee. It is worth mentioning that in order to set the tone, establish a good rapport with the trainers and make them feel comfortable, we asked them about their work in the memory area and how long they have been in this domain before moving to the interview's questions.

3.3.2.3 Data Collection Procedures for the Interview

Four memory trainers have been interviewed online via Facebook Messenger application. The interviews were conducted using the Arabic language since it is the native language of the interviewees. After tape-recording the interviewees, we have listened to what they said many times in order to transcript the tapes. Afterwards, we have cleaned the gathered data and got what we need in order to analyze it later.

3.4 Population and Sampling

The population of this study was Master One students of English language at Mohamed Kheider University of Biskra, Algeria for the academic year 2018/2019. It consisted of 283 students. One fifth of this number that is represented by roughly 57 students was taken as a sample through simple random sampling to carry out this study.

3.5 The Results of the Study

3.5.1 Students' Questionnaire

Section One: Students' Prior Experiences with Propositional Knowledge Retention

1. Is passing the examinations your only goal behind memorizing information?

Table 3.2 *Students' views of passing the examinations as the only goal behind memorizing information*

Options	Number of respondents	Percentage
Yes	39	68 %
No	18	32 %
Total	57	100 %

The first question was intended to be direct and easy to answer in order to make the students engaged in answering the questionnaire. By asking this question, we sought to check the truthfulness of the common saying that the goal of most students behind memorizing information is to pass the examinations. Besides, it aimed at knowing if students have other goals. The majority of the students representing 68 % have reported that they revise what they have learned in order only to pass the examinations; however, 32 % of them have revealed that passing the examinations is not their only goal behind memorizing information.

- If 'No', please specify other goals

The students who have other goals behind memorizing information have been asked to specify them. It is worth mentioning that all of these students have answered this sub-question. Actually, most of the answers were nearly similar in which the students have expressed that their other goal is to gain more knowledge and use it in the future when needed.

2. Which type of these two types of knowledge are you more likely to remember?

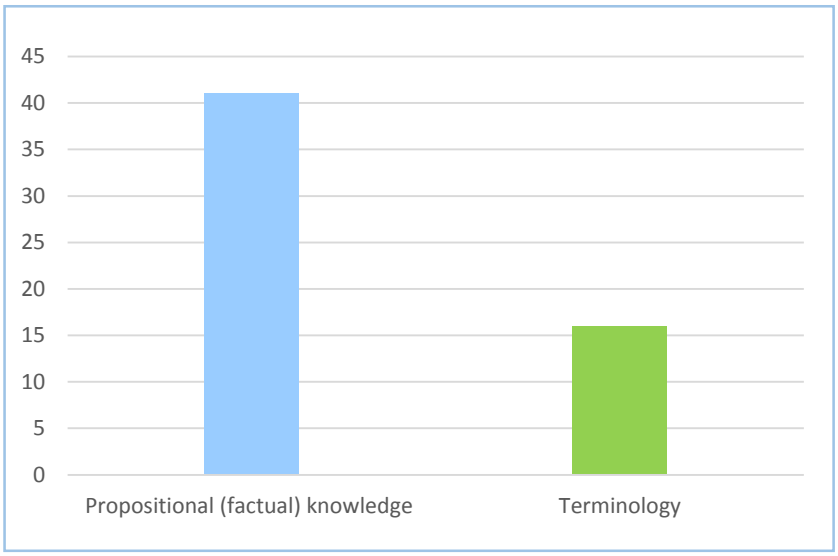

Figure 3.1 The most remembered type of knowledge by students

Since propositional (factual) knowledge and terminology are probably the most types of knowledge students tackle with, especially in language learning, these two types were the options of this question to know which type of them students remember more. In addition, because this study explores the retention of propositional knowledge in particular, it was reasonable to ask this question. Before submitting the questionnaire, we anticipated that the majority would opt for terminology, but surprisingly most of them have answered that they are more likely to remember propositional knowledge over terminology. More precisely, 41 students who represented 72 % of the respondents have stated that they remember general facts more, while 28 % have claimed that they are more likely to remember the meaning of words.

3. In order to revise a material for the examination, do you revise it:

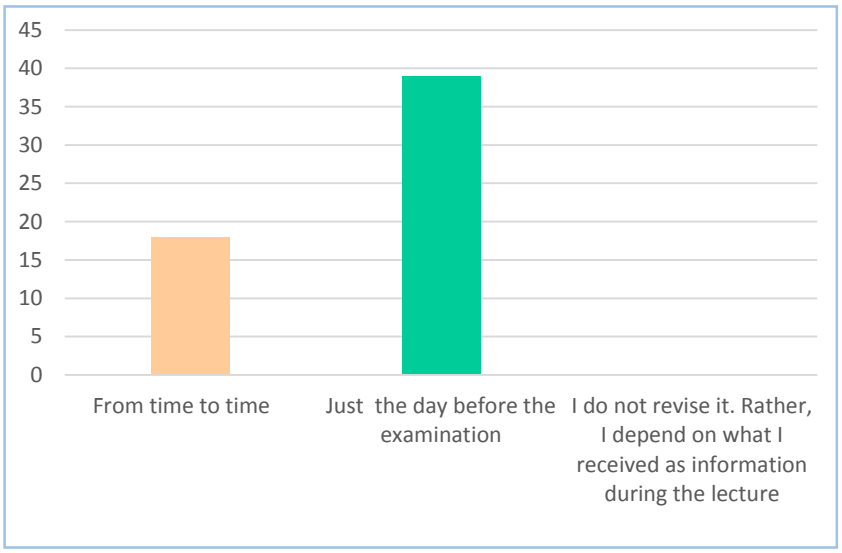

Figure 3.2 The frequency of materials revision

Through asking this question, we aimed to figure out the students' habits concerning the materials revision and the preparation for the examinations. Moreover, we sought indirectly to know if they leave time intervals between revision sessions or they cram the revision before the examination. The options for this question were three that we thought they are the potential options. The majority representing 68 % of the respondents have answered that they revise their materials just the day before the examination. However, 32 % of them have answered that they revise their materials from time to time. Besides, no one of the respondents relies only on the lectures in the preparation for the examinations.

4. How long do you often retain (keep in memory) what you have learned as factual knowledge before forgetting it?

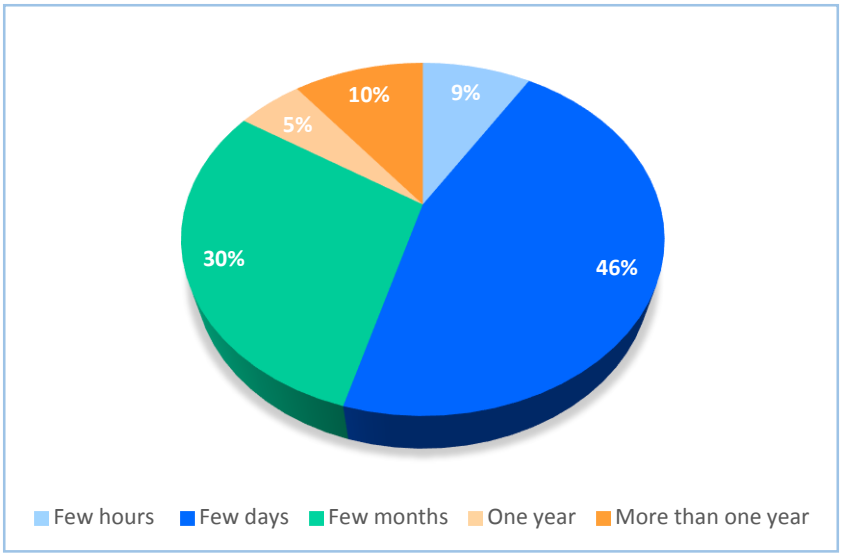

Figure 3.3 Duration of propositional (factual) knowledge retention

We endeavored through including this question to know how long students retain what they have learned as knowledge before forgetting occurs. This question had different options that represented different periods of time ranging from a few hours to more than one years. About 46 % of the respondents have revealed that they retain what they learned as propositional knowledge for a few days. However, 30 % of the respondents have said that they can do that for a few months. Some students who represented 10 % of the respondents have reported that they retain propositional knowledge for more than one year. Moreover, 9 % of the respondents have answered that they keep what they learned as propositional knowledge for only a few hours. In addition, three students who represented 5 % have revealed that they retain their propositional knowledge for roughly one year.

5. During the examination, do you encounter any difficulties in recalling what you have revised?

Table 3.3 *Difficulties during information recall*

Options	Number of respondents	Percentage
Yes	51	89 %
No	6	11 %
Total	57	100 %

The large majority of the students representing 89 % of the respondents have answered that they face difficulties in recalling information during the examinations, while only six students out of 57 of the respondents have answered that they do not encounter any difficulties during the examination to recall what they have revised.

- If 'yes', what do you think is the reason (s) behind this inability?

Table 3.4 *Reasons behind the difficulties during information recall*

Options	Number of respondents	Percentage
Lack of preparation for the examination	21	41 %
Lack of concentration during the revision session	18	35 %
Overlap of information with each other (old information with recent one)	17	33%
The big amount of information you should memorize	33	65 %
Other reasons	2	4 %

Moreover, for the sake of identifying the reasons underlying students' inability to recall information, we asked the students who have answered that they face difficulties in recalling

to choose the reason (s) behind these difficulties in their views. In addition, we added another option (other reasons) to enable the respondents to write down other reasons that have not been mentioned among the main options. The majority (65 % of the respondents) of the respondents have clarified that the big amount of information they should memorize prevents them to recall it. However, 41 % have expressed that they face difficulties in recalling because they do not prepare well for the examination. Besides, 35 % of the respondents have reported that they do not concentrate during the revision session which makes them unable to recall the information later. In addition, 33 % of the respondents have said that the reason behind their inability to recall lies in the overlap of information with each other. Furthermore, two students have added other reasons for difficulties of recalling information. One of these two students has written that s/he suffers from examination fear that hinders him/her to recall information; however, the other students have just written 'Exam anxiety'.

6. How much acquired information do you usually recall during the examination?

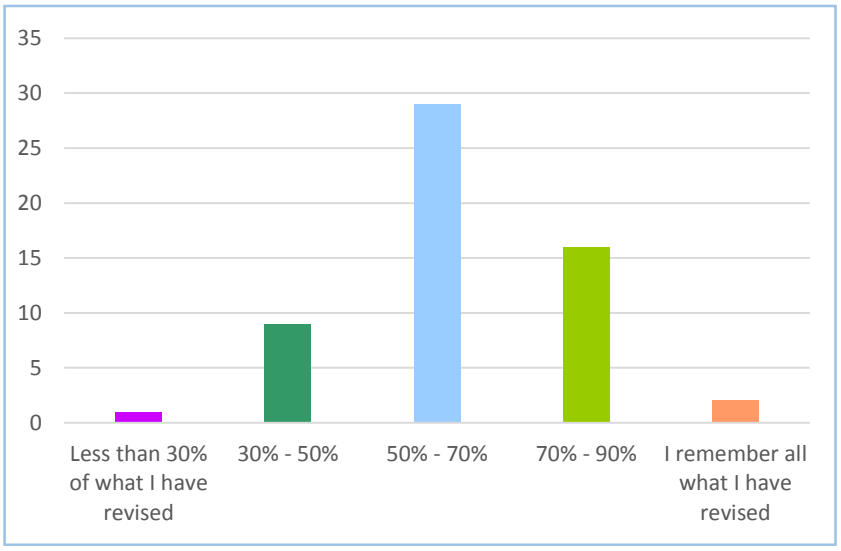

Figure 3.4 Information amount recalled during the examination

The goal behind asking this question is to know how effective their information recall is. About 29 students representing 51 % of the respondents have answered that they recall between 50 % and 70 % of the information during the examination. Besides, 16 students (28

% of the respondents) have revealed that they succeed to recall between 70 % and 90 % of information during the examination. Moreover, nine students (16 % of the respondents) have said that they recall between 30 % and 50 % of what they have memorized. Furthermore, only two students representing 4 % of the respondents have reported that they remember all what they have revised. However, one student who represented 2 % of the respondents has answered that during the examination, s/he remembers less than 30% of what s/he has revised.

7. Do you use any techniques to help you improve your memory and your recall later?

Table 3.5 *The use of techniques to improve memory*

Options	Number of respondents	Percentage
Yes	48	84 %
No	9	16 %
Total	57	100 %

Human memory can be improved by using techniques to better knowledge retention and boost the recall of this knowledge later. The large majority of students representing 84 % of the respondents have reported that they use techniques to improve their memories and recall, while 16 % of them have said that they use no techniques.

- If 'yes', which technique (s) do you use?

Table 3.6 *Techniques used by students to improve memory*

Options	Number of respondents	Percentage
Ask questions about the information I want to memorize	15	31 %
Use schemas and mind maps	20	42 %
Link the to-be-revised information with your prior knowledge	9	19 %
Relate the information you want to memorize to your personal life	12	25 %
Repeat the information until you memorize it	22	46 %
Summarize the information in your own words	28	58 %
Talk out loud and pretend that you are a professor	22	46 %
Other techniques	2	4 %

To have an idea about the techniques students use to improve their memorisation and recall, we included a sub-question to ask them to choose the technique (s) they apply. Additionally, we added another option (other techniques) to enable students to write other techniques that are not among the main options. A considerable number of students representing 58 % of the respondents have revealed that they summarize the information in their own words in order to better memorize it. Besides, 46 % of the respondents have clarified that they repeat the information until they memorize it. Moreover, 46 % of the respondents have reported that they use the technique of pretending as a professor to help them memorize the information better.

Furthermore, 42 % of the respondents have said that they rely on schemas and mind maps as a technique for boosting memory. In addition, 31 % of the respondents have reported that asking questions about the information they want to memorize helps them to memorize

it. As for the technique of relating the information to the personal life to memorize it, 25 % of the students have stated that they prefer to do that. Finally, about 19 % of the students have revealed that they prefer to link the to-be-revised information with their prior knowledge. Only two students representing 4 % of the respondents have added another technique which is re-writing the information they want to memorize in a piece of paper.

8. Do you agree that in order to retain the acquired information you have to be tested about it?

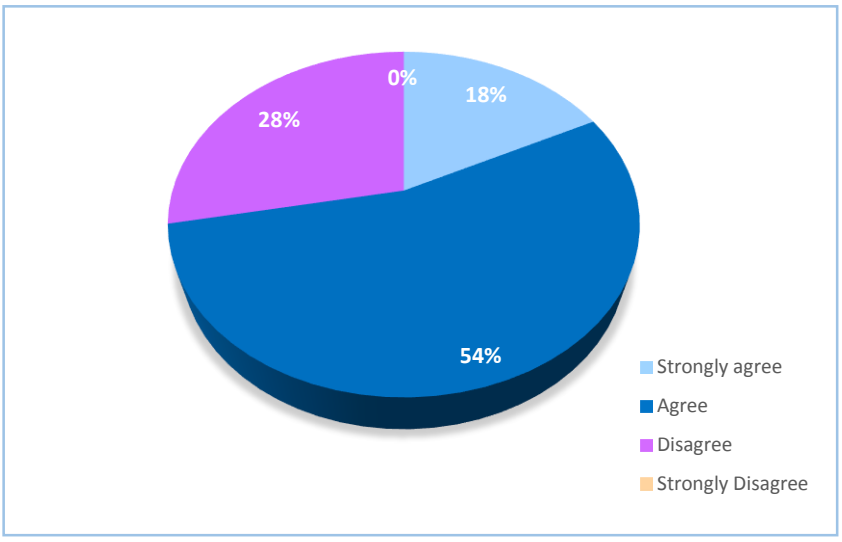

Figure 3.5 Students' views of being tested about what they have learned

Since testing is a crucial aspect in the spaced repetition technique proposed in this study, we aimed to discover students' views of being tested about what they have learned. That is, we sought to know the degree of agreement or disagreement with undergoing testing. As shown by the above figure, 54 % of the respondents have agreed that being tested about what acquired as information helps to retain it, while, 28 % of the respondents have disagreed with the idea that testing improves retention. The rest of the respondents representing 18 % have strongly agreed that having tests about the information we acquired helps us to retain it. However, no one of the respondents has opted for the last option (strongly disagree).

- Whatever your answer, please justify it

It is worth noting that the large majority of students have answered this sub-question. On the one hand, many students who agreed upon the positive effect of testing on information retention view testing as a way to check if the information is retained or not. Interestingly, one student has clarified that tests help us to find out the weaknesses in our revision that need to be treated. Besides, other students have justified their answers by stating that testing affords an opportunity to practice and repeat the information which helps to consolidate it in memory and recall it later. On the other hand, some students do not believe that testing enhances knowledge retention. Rather, they think that grasped information does not need to be tested. However, one student has said that testing makes the learner memorize information just to pass the examination then forget it. Another student has claimed that testing cannot help us in subjects such as discourse analysis which need critical thinking rather than rote memorization.

Section Two: Students' Views towards Knowledge Retention

1. To what extent do you think that forgetting what you learned as knowledge can affect your learning?

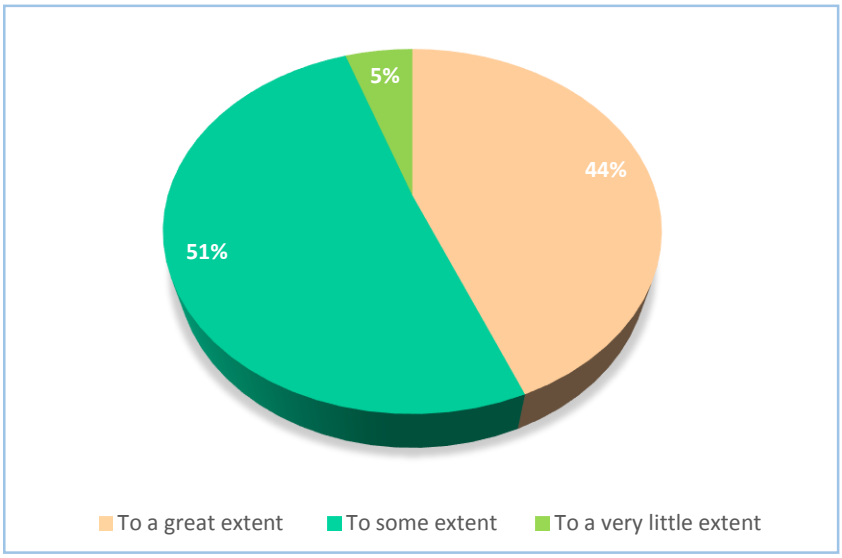

Figure 3.6 Students' views of the effect of forgetting on their learning

Forgetting is a natural phenomenon that absolutely has an effect on students learning. Because when we talk about knowledge retention we necessarily talk about forgetting as an opposite phenomenon, as it were, we included this question to ask students about the extent to which they view that forgetting affects their learning. About half of the respondents representing 51 % have revealed that forgetting what they learned as knowledge to some extent affects their learning. However, a considerable number of the respondents representing 44 % have reported that forgetting significantly affects their learning. In addition, only 5 % of the respondents have said that their learning is not affected a lot when they forget their learned knowledge.

- How?

The large majority of the students have answered this sub-question. As for students who view that forgetting affects learning, the majority of them have explained that understanding new knowledge may depend on understanding the previous one. Consequently, forgetting the old knowledge affects the learning of the new one. In addition, many students think that the effect of forgetting on learning appears through getting bad scores.

Moreover, some of the students claimed that forgetting leads to build incomplete knowledge which leads in turn to an inefficient and pointless learning process. Accordingly, other students have given us explanations based on their experiences as English language learners by saying that forgetting some vocabulary and grammar rules affects their performance in speaking. Furthermore, a number of students have revealed that forgetting disappoints them and discourages their learning performance. On the other hand, some students claimed that forgetting does not affect their learning to a great extent because they think that they do not forget what they understand well or what they think is important. Besides, one student has written that the effect of forgetting depends on the knowledge we

forget; for instance, knowing about grammar rules or vocabulary is crucial for a foreign language learner unlike knowing about civilization or culture of the language.

2. Do you think that protecting your learned knowledge from fading (disappearing) is a necessity even after your graduation?

Table 3.7 *Students' perception of the importance of protecting learned knowledge after graduation*

Options	Number of respondents	Percentage
Yes	37	65 %
No	20	35 %
Total	57	100 %

This question is related to the first question in the first section. After having explored students' goals behind memorizing information, we aimed through this question to know if they are aware of protecting what they learned as knowledge from fading after passing the examinations and even after their graduation. As shown in the above table, 65 % of the respondents believe that maintaining learned knowledge from disappearing is necessary even after the graduation, while 35 % of the respondents believe that protecting what they learned is not necessary.

- If 'yes', why?

It is worth noting that the large majority of students have answered this sub-question. Students have widely explained that they must protect their learned knowledge from fading because they need it in the future to proceed with their studies or to be engaged in professional life. Besides, some students have said that they find it embarrassing and even shameful if someone asks them about what they learned and they fail to answer. In this respect, one student has added that failing to answer means that s/he is not qualified; for

example, for a job. However, other students have expressed that they have to protect their knowledge to transmit it to others. Moreover, some students believe that protecting knowledge from disappearing is necessary because they believe that knowledge is the purpose of learning and the proof that learning is effective; otherwise, their graduation becomes useless.

Section Three: Students' Perception towards Spaced Repetition Technique

1. Have you ever heard of spaced repetition technique for better memorization?

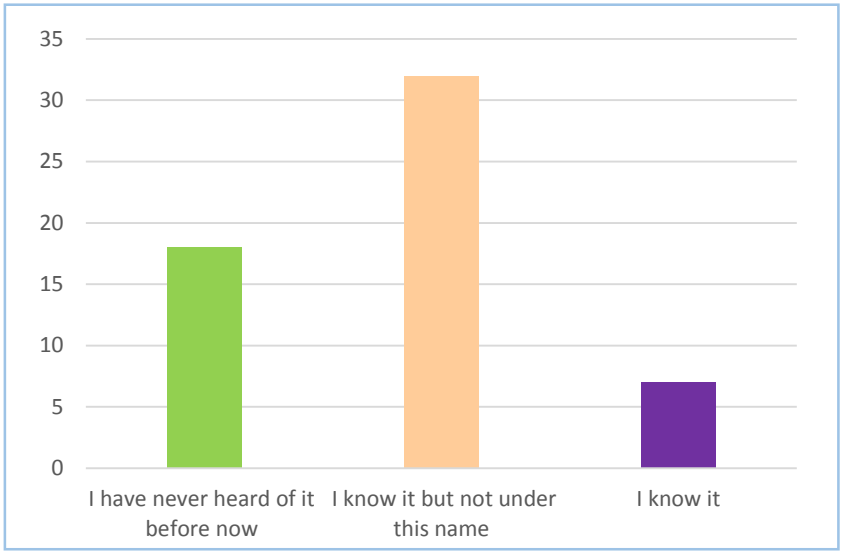

Figure 3.7 Students' acquaintance with the spaced repetition technique

Learning techniques used by students are several. That is why we asked this question to see if students have an idea about spaced repetition technique in particular. The results show that 18 students representing 32 % of the respondents have said that they have never heard of the spaced repetition technique before. About 32 students who represented 56 % of the respondents have reported that they know the technique but not under spaced repetition name. However, only seven students representing 12 % have claimed that they know this technique under this name.

2. For those who apply the spaced repetition technique, how often do you apply it?

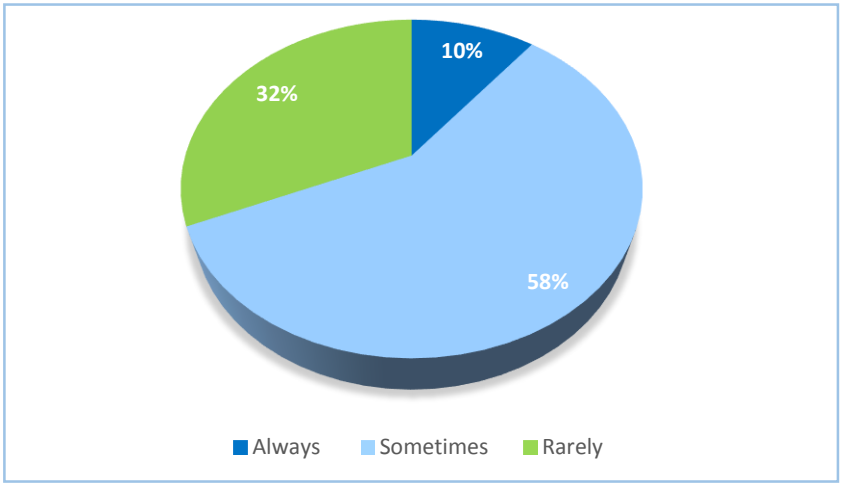

Figure 3.8 The Frequency of applying the spaced repetition by students

Because we aimed to gather as much information as possible about the spaced repetition technique, this question and the two coming ones in this section have been addressed only to students who have applied this technique. Through this question, we sought to know the frequency of applying the spaced repetition technique by students. The majority of students representing 58 % have argued that they apply the spaced repetition technique sometimes. Additionally, 32 % of them have argued that their use of this technique is rare. However, 10 % of the respondents have claimed that they always apply the spaced repetition technique.

3. In applying the spaced repetition technique, do you revise what you learned?

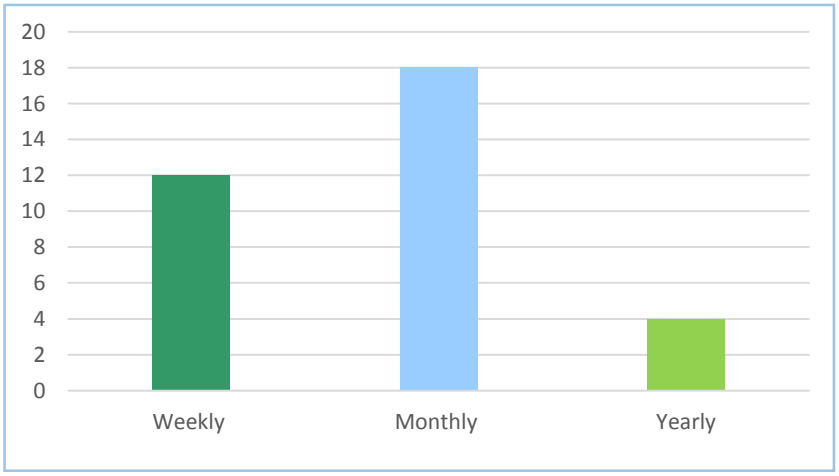

Figure 3.9 Timing of using spaced repetition

This question tried to explore the way students apply spaced repetition. It is important to say that it was impossible to ask the students to pinpoint the time intervals between the revision sessions they use while applying spaced repetition. Instead, we tried to create other options that seemed to be inclusive of this question. Consequently, we asked the students to choose if they revise what they learned weekly, monthly, or yearly. As the results show, 53 % of the respondents have stated that in applying spaced repetition they revise what they learned monthly. Moreover, 12 students who represented 35 % of the respondents have revealed that they review their learned information each week. The rest of students representing 12 % have answered that they revise what they learned yearly.

4. If you have tried this technique before, are you satisfied with the efficiency of using spaced repetition technique in enhancing your knowledge retention?

Table 3.8 *Students' satisfaction of using spaced repetition*

Options	Number of respondents	Percentage
Yes	32	89 %
No	4	11 %
Total	36	100 %

At the end, it was reasonable to ask the students about their satisfaction with the efficiency of the spaced repetition as a learning technique to improve knowledge retention. The vast majority representing 89 % of the students have found this technique effective; whereas, 11 % of them have found it ineffective.

- If 'No', why?

In connection with the above question, we asked the students who were not satisfied with the efficiency of the spaced repetition technique to further elucidate their answer. All students who represented 11 % have answered this question. One of them has written that

this technique takes time, decreases motivation and may give poor marks in examinations. Another one has said that although s/he applies this technique, forgetting still occurs. The third student has stated that ‘‘I haven't tried honestly... but I'd like to give it a shot maybe it will be the solution to my problem of memorization’’. The last student has claimed that s/he does not benefit from the spaced repetition technique because s/he does not revise everyday.

Section Four: Further Suggestions

If you have any suggestions about the use of spaced repetition technique in improving long-term propositional knowledge retention, please propose them below.

This section was included as a further space that affords an opportunity for students to write down any suggestions concerning the use of the spaced repetition technique in enhancing long-term propositional knowledge retention. In fact, what students have written in this space were comments on the efficiency of the spaced repetition technique rather than suggestions. Nevertheless, one student suggested using visual aids to enhance retention. Another student suggested using this technique with the modules that require deep memorization, such as civilization, literature and history. Other students provided us with recommendations about the use of spaced repetition technique in which one of them recommended learners to find a way to incorporate this technique in their educational routine. Another student also recommended learners to find the best application of the spaced repetition technique and to be consistent in applying it.

3.5.2 Memory Trainers’ Interview

Q1: In your opinion, what are the main causes behind forgetting among the learners?

Through asking this question, we aimed to know the main causes of forgetting in interviewees’’ view. Most of them have agreed that the main cause is the use of the massed repetition rather than using the spaced repetition. **Trainer 2 and 4** have added that in

addition to the first cause, forgetting can also occur because of the failure to encode the information in a good way. **Trainer 4** also said that the attention to the information and understanding it are two important factors to memorize and recall this information later.

Q2: How do you find the efficiency of the spaced repetition technique in improving long-term knowledge retention and enhancing the recall?

Regarding this question, there was a total agreement among the interviewees that the spaced repetition is a very efficient memory technique in improving long-term knowledge retention and enhancing the recall. **Trainer 2 and 3** have commented that this technique is very efficient if the trainee follows the instructions and applies it, as it should be.

Q3: With whom did you apply this technique?

We sought through including this question to know the trainees with whom the interviewers applied the spaced repetition technique. The interviewers have said that their trainees were primary school students, middle school students, and university students as well as common people.

Q4: How old were these trainees?

As for the age of the trainees, the interviewers have claimed that they applied the spaced repetition technique people with different ages. Generally, the age intervals they have provided ranged from 8 and 72 years old.

Q5: Which type of knowledge did you target in applying this technique?

Because we aimed at collecting as much information as possible about the application of the spaced repetition technique, we asked the trainers about the types of knowledge they targeted in applying this technique. In fact, the trainers have reported that they applied this technique with their trainees to target different kinds of knowledge through learning new

vocabulary, memorizing verbatim texts and even improving their memories to better remember people faces, telephone numbers and everyday life tasks. Commenting on this question, **Trainer 3** has said that the spaced repetition is a flexible technique in which it can be applied on different types of knowledge. In this respect, the trainers have provided us with many examples. For instance, **Trainer 1** has revealed that with his students of medicine, he applies the spaced repetition on medical topics, such as diseases, symptoms, diagnosis and treatments. He has also given us an example of these topics which was about the peptic ulcer. Moreover, **Trainer 2** has said that he applied this technique with middle school students to make them memorize historical events. Furthermore, **Trainer 4** has revealed that she apply this technique to teach her trainees the types of intelligence and their definition.

Q6: How was the mechanism of applying this technique?

We endeavored through asking this question to have an idea about the mechanism of applying the spaced repetition technique. Actually, the trainers have explained different ways of applying the spaced repetition. These were their replies: **Trainer 1** has said that after explaining the technique to the trainees, we give them the target information and ask them to revise it after one hour then after one day then after one week. Afterwards, the trainees are supposed to explain what they learned through a test. The same mechanism is followed by **Trainer 2**, but the trainees, in this case, revise the information through turning it into a mind map that presents the details of the lesson and then they are tested after one month. **Trainer 3** has insisted that the information, foremost, should be clearly encoded then he asks the trainees to revise it as follows: First repetition—1 hour, second repetition—24 hours, third repetition—1 week, fourth repetition—2 weeks, fifth repetition—20 days, sixth repetition—1 month, seventh repetition—45 days, last repetition—2 months. However, he considers that the exposure to the information with each repetition acts as a test in itself. **Trainer 4** has said that after giving the trainees the information, they turn it into a mind map.

Trainer 4 has added that she follows the trainees in the first and the second day then she asks them to continue applying by themselves at home.

Q7: How was the impression of the trainees of the efficiency of this technique?

To further figure out the spaced repetition technique appliers' satisfaction with its efficiency, we asked the interviewers about their trainees' satisfaction. All of them have revealed that their trainees were very satisfied and some of them have given us percentages of 75 % and 80 %. **Trainer 2** has commented on this question by saying that 75 % of the trainees were satisfied, while 25 % were not satisfied. Those unsatisfied trainees according to Trainer 2 lacked the mental and the psychological readiness and will to apply this technique as well as they were not disciplined in applying it, as it should be.

Q8: What are the disadvantages of the spaced repetition technique in your opinion?

We aimed through asking this question to know if the spaced repetition technique has disadvantages. In this regard, **Trainer 1 and 2** have claimed that this technique takes time. **Trainer 2** has added that this technique seems to be boring for those who are not serious. Besides, **Trainer 3** has reported that this technique needs to be applied with other memory techniques to get the desired results.

Q9: Do you have any suggestions that help in applying this technique?

We have asked the interviewees as memory experts about their suggestions that may help in applying the spaced repetition technique. In fact, many suggestions have been proposed. **Trainer 2** has recommended the trainees to change the revision place from time to time to avoid boredom as well as change the strategies of applying the spaced repetition, such as using mind maps, images, videos, and role-plays. **Trainer 4** has affirmed that all senses should be engaged when applying this technique because the more the learner uses senses, the better will be the results. Importantly, all the trainers have suggested to combine

the spaced repetition technique with other memory techniques. In this respect, the trainers have mentioned many strategies, such as speed reading, mind maps, using images, linking the information to another one.

3.6 Discussion of the Results

The present study aimed mainly at investigating the use of the spaced repetition in enhancing long-term propositional knowledge retention. Moreover, it sought to highlight the knowledge forgetting phenomenon that naturally accompanies the learning process. Accordingly, it also attempted to increase learners' awareness about the importance of protecting their learned knowledge from fleeting. Simultaneously, it intended to draw learners' attention to the use of learning techniques that enable them to retain what they have learned for a long period of time.

The findings drawn from the analysis of the obtained data using two collection data methods were positive in many aspects. At the outset, the results of the students' questionnaire analysis showed that the overwhelming majority of the students suffer from forgetting phenomenon in which they often fail to retain what they have already learned and recall it when needed. A great number of the students believe that the main reasons of their inability to recall what they have learned are the big amount of information they should memorize, the lack of preparation for the examinations and the lack of concentration during the revision. In addition, many students opine that they fail to recall what they have revised because their old acquired information overlaps with the information acquired recently which is explained by one of the well-known forgetting theories—the interference theory.

However, most of the memory trainers have agreed in the interviews that the main cause of forgetting is the use of the massed repetition by the students when they come to revise rather than using the spaced repetition technique. Therefore, this cause given by the trainers

may carry the explanation of the most of the causes stated earlier by the students. In connection with this, the vast majority of the students have reported that forgetting affects their learning because they believe that new knowledge is built based on old one. That is, forgetting the old knowledge affects the learning of the new one which results eventually in ineffectual learning process.

As shown by the results of the students' questionnaire, the large majority of the students use techniques for reducing forgetting and promoting their memorisation of the information and underpin its recall. To have an idea about the techniques used by the students, we have suggested some of them that we thought students apply most. Unsurprisingly, nearly half of the students use the classical way of repetition—the rote repetition or what is called maintenance rehearsal to memorize information. This technique can be efficient only to retain the information for a short period of time without transferring it to the long-term memory.

However, many other students use other techniques that ensure the deep processing of the information which result in memorizing it for a long period of time. For example, asking questions about the information they want to memorize or acting as a professor. Besides, other techniques for improving memory that fall under the organization technique are used by the students, such as using schemas and mind maps, summarizing the information in the learners' words and relating the information to their personal life to create helpful cues for retrieving the information when needed. In addition, few students revealed that they make associations between the to be-revised information and the prior knowledge as a memorizing technique that helps to make the information easy to be recalled.

Moreover, to better understand the current issue, we have centered our sights on the students' prior experiences with propositional knowledge retention. In doing so, different

aspects of their prior experiences have been taken into account and tackled in the students' questionnaire. First, the results revealed that the vast majority of the students have explained that they are more likely to remember propositional (factual) knowledge over terminology. Even though the propositional knowledge as one of the most types of knowledge students tackle with in the educational context is more likely to be remembered comparing with terminology. This fact does not deny that a great number of the students often forget what they have learned as propositional knowledge a few days or months later as the results showed. In addition, concerning the amount of the information the students often recall during the examinations, the results showed that about half of the students succeed only to recall between 50-70 % of what they have revised.

Regarding the students' habits concerning the materials revision and the preparation for the examinations, the results have shown that the majority of the students leave the revision to the last minutes. However, about one third of the students have reported that they exposure to the materials from time to time. In other words, they incorporate time intervals between the revision sessions. Thus, based on this, we come out to the result that the majority of the students tend to use the massed repetition rather than the spaced repetition technique in order to memorize what they have learned. It should be here pointed out to that these findings remind us of the main cause of forgetting given by most of the memory trainers.

The students' questionnaire also helped us gather information about the students' views of the role of testing in knowledge retention. The vast majority of the students have agreed that being tested about what they acquired as information helps retain it because they believe that through testing they can check how successful the retention is, find out the weaknesses in their revision, and exposure to the information over and over. On the other hand, most of the students who believe that testing does not help enhance knowledge retention think that understanding the information ensure its retention. That is, those students are not aware that

understanding the information through a deep processing only is not sufficient to retain it at the long term in which even the information we understand well can be prone to forgetting if it is not rehearsed.

Furthermore, the students' questionnaire revealed that the majority of the students memorize what they have acquired as information solely to pass the examinations as it was anticipated. That is, the students' ultimate goal behind memorizing what they learned is passing the examinations even though the majority of them have claimed that protecting their learned knowledge from disappearing after passing the examinations is important. Thus, we can conclude based on these findings that the students are not really aware of the importance of retaining and protecting knowledge since the majority of them memorize knowledge only to pass the examinations.

Since the main aim of this research study is investigating the use of the spaced repetition technique in enhancing propositional knowledge retention at the long term, we endeavored to extract as much information as possible from both the students' questionnaire and the memory trainers' interview about this technique. Initially, the analysis of the students' questionnaire has shown that about one third of the students do not know this technique. However, about two thirds of them know it whether under this name or under other names. Besides, the majority of the students who use the spaced repetition have revealed that they apply it sometimes; whereas, only few students have reported that they always apply it. Moreover, most of the students have explained that they incorporate medium length time intervals between the revisions.

The analysis of the memory trainers' interview revealed that the spaced repetition technique can be applied with different people including students and common people as well as with different ages including children and adults. In addition, this technique can be

applied to target different types of knowledge including propositional knowledge that we focus on in this research study. Moreover, the analysis of the interview revealed that there is a total agreement among the memory trainers that the spaced repetition is an efficient technique in improving long-term knowledge retention in general including the long-term retention of the propositional knowledge. In connection with this, the analysis of the results drawn from both data collection methods about the impression of the appliers of the spaced repetition technique revealed that the large majority of them were satisfied with its efficiency in improving long-term knowledge retention. Furthermore, even though the memory trainers and the appliers of the spaced repetition have reported that this technique is efficient, they have claimed that it has some disadvantages in which it consumes time and may make the appliers feel bored.

However, concerning the mechanism of applying the spaced repetition technique, the results of the memory trainers' interview showed that there are many mechanisms can be followed in applying this technique as long as its principles, namely the spacing effect and the testing effect, are ensured. In this respect, the memory trainers proposed many suggestions that may help in applying the spaced repetition technique like changing the revision place to avoid boredom, engaging many senses, and combining this technique with other memory techniques to get better results.

3.7 Synthesis of the Findings

In this section, we aimed at synthesizing the main findings and conclusions that have been drawn from the analysis of the obtained data in order to answer the research questions and confirm the research hypotheses proposed at the outset of this research study. To reiterate, this study was an attempt to investigate the use of the spaced repetition technique in enhancing the long-term propositional knowledge retention. Moreover, it sought to

highlight the forgetting as a natural and concomitant phenomenon to the learning process. Furthermore, it intended to increase the learners' awareness about the importance of protecting their learned knowledge from fleeting.

First, the results showed that the students suffer from forgetting phenomenon that accompanies their learning process. In other words, the students often face difficulties in retaining what they have learned as knowledge for a long period of time and recall it when needed. Besides, the majority of them believe that forgetting affects their learning and makes it inefficient and pointless. Thus, to cope with forgetting, the students use memory techniques to improve their memories and boost the recall. In addition, this inability to memorize the information and recall it later is due to many causes that are related in a way or another to the students' habits in leaving the revision to the last minutes and massing all the information they want to memorize together in a single revision session. The memory trainers have backed up this finding in which they opine that the main cause of forgetting among the students is using the massed repetition that makes the information unstable and easy to be forgotten.

Moreover, we attempted to investigate the students' awareness about the importance of retaining and protecting their learned knowledge from evanescing for a long period of time. The findings have been drawn from the questionnaire indicate that the majority of the students revise and memorize what they have learned solely to pass the examinations even though the majority of them think that retaining and protecting learned knowledge from disappearing is important. With reference to these findings, it can be deduced that the students are not really aware of the importance of protecting their learned knowledge at the long term since they revise and memorize it only to pass the examinations.

Furthermore, we sought mainly to investigate the use the use of the spaced repetition technique in promoting long-term propositional knowledge retention. Based on the present study findings, it can be said that the spaced repetition is viewed to a great extent as an efficient learning technique to reduce forgetting and enhance the long-term propositional knowledge retention. Accordingly, the majority of the appliers of this technique were satisfied with its efficiency. To that end, all the following research hypotheses proposed at the beginning of this research study were confirmed.

- There are different causes behind forgetting learned knowledge.
- Students are not aware of protecting what they have learned as knowledge after passing the examinations and after their graduation.
- The use of the spaced repetition technique can help learners improve their long-term propositional knowledge retention.

Conclusion

The present chapter has presented the field work of this research study that aimed at investigating the use of the spaced repetition technique in enhancing long-term propositional knowledge retention. First, this chapter has provided a clear description of the methodology adopted in conducting this research. Besides, it has displayed the data gathered through this study followed by a detailed analysis of the results. Moreover, it has sought to confirm the hypotheses proposed at the beginning of this research study through a discussion of the obtained results. Finally, the current chapter has provided a synthesis of the findings as well as the conclusions we came out with in this research.

General Conclusion

This study stemmed from our personal experience and observation that the students often encounter difficulties in retaining what they have learned as knowledge for a long period of time and recalling it when needed. Besides, the majority of the students revise and memorize what they have learned solely to pass the examinations. Consequently, they find themselves unable to recall their learned knowledge after passing the examinations and after their graduation. As a result, when students learn then forget what they have learned as knowledge results eventually in inefficient and pointless learning process.

The present study aimed mainly to investigate the use of the spaced repetition technique in enhancing long-term propositional knowledge retention. In order to achieve the intended aim, a qualitative research approach was adopted. Moreover, a semi-structured questionnaire and a semi-structured interview were used as data collection methods. The findings of this research study revealed that there are different causes behind forgetting what the students have learned as knowledge. In addition, they showed that the students were not really aware of the importance of protecting their learned knowledge from fleeting after passing the examinations and even after their graduation. Moreover, the spaced repetition which is based on incorporating expanding time intervals between the information revisions is viewed as an efficient learning technique that helps to a great extent improve the students' long-term propositional knowledge retention.

With regard to the obtained findings, this study provided an opportunity to better understand the long-term propositional knowledge retention issue as well as drew the students' attention to the importance of protecting their learned knowledge and encouraged them to use memory techniques to do so. In light of the present results, this study succeeded to provide answers to the research questions and confirm the research hypotheses. Finally,

the present findings may pave the way to future research on the long-term knowledge retention area.

Recommendations

The following are some recommendations that can be drawn from this study:

For learners

- Learners are recommended to attend memory training courses to learn techniques and strategies that help them improve their knowledge retention and recall.
- They should urge themselves to apply the spaced repetition technique and incorporate it into their learning routine to promote their long-term retention of what they have learned as knowledge.

For teachers

- Teachers need to apply the spaced repetition technique with their students by incorporating a brief review at least of the main concepts that have been previously learned. Here we are not referring to the review that takes place after each lesson about what has been tackled with in the previous lesson, rather, we refer to the review that targets the long-term knowledge retention. In this case, the time interval between the reviews should be as long as possible starting with a time interval of at least a few weeks.
- Teachers should use homework assignments to ensure the students' exposure to the information previously learned. In this respect, teachers should include and focus on the information that has been learned several weeks or months earlier.
- Since testing is one of the pillars that the spaced repetition technique is based on and because testing has proven its efficiency in improving long-term knowledge retention, teachers should incorporate more quizzes and examinations.

For memory trainers

- Memory trainers should coordinate with the educational institutions' administrators to organize memory training courses for the benefit of the students and make this kind of courses within their reach.

For researchers

- Future research is recommended to be carried out on long-term knowledge retention since this it is of immense importance to ensure successful learning. They can; for example, conduct other studies to explore the use of other memory techniques in enhancing long-term knowledge retention. Long-term knowledge retention can also be examined through targeting other types of knowledge.

Limitations of the Study

The present study aimed mainly to investigate the use of the spaced repetition technique in enhancing long-term propositional knowledge retention. The findings revealed that this technique is efficient in improving the students' long-term propositional knowledge retention. Even though this study achieved the intended aim, it; however, had two main limitations. First, the lack of prior research studies on the topic, especially the ones that tackled the spaced repetition technique. This lack of studies was challenging to collect a sufficient number of sources about the issue. Second, the analysis of the research findings revealed that the data collected through the questionnaire about the students' awareness about the importance of protecting learned knowledge was not sufficient to address this aspect, as it should be. In future research, this aspect should be targeted through asking more questions in order to collect detailed information about it.

References

Alves, M. V. C., & Bueno, O. F. A. (2017). Retroactive interference: Forgetting as an interruption of memory consolidation. *Trends in Psychology*, 25(3), 1055-1067. doi: 10.9788/TP2017.3-07En

Anderson, J. R. (2015). *Cognitive psychology and its implications* (8th ed.). Retrieved from https://www.amazon.com/Cognitive-Psychology-Implications-John-Anderson/dp/1464148910

Atkinson, R. C. & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory* (pp. 89-195). Retrieved from http://www.rca.ucsd.edu/selected_papers/2_Human%20memory_A%20proposed%20system%20and%20its%20control%20processes.pdf

Baddeley, A. (2009). What is memory? In A. Baddeley, M. W. Eysenck & M. Anderson, *Memory* (pp. 1-17). Retrieved from https://www.amazon.fr/Memory-Alan-Baddeley/dp/1848720017

Bernstein, D., & Nash, P. W. (2008). *Essentials of psychology* (4th ed.). Retrieved from https://sangu.ge/images/EssentialsofPsychology.pdf

Biggam, J. (2001). Defining knowledge: An epistemological foundation for knowledge management. In B. Werner & L. Palagi (Eds.), *Proceedings of the 34th Hawaii International Conference on System Sciences*. Retrieved from http://cs.unibo.it/~gaspari/www/teaching/defining_knowledge

Bilbrough, N. (2011). *Memory activities for language learning*. Cambridge: Cambridge University Press

Bolisani, E., & Bratianu, C. (2018). *Emergent knowledge strategies: Strategic thinking in knowledge management*. Retrieved from https://www.springer.com/us/book/9783319606569

Carpenter, S. K., Cepeda, N. J., Rohrer, D., Kang, S. H. K., & Pashler, H. (2012). Using spacing to enhance diverse forms of learning: Review of recent research and implications for instruction. *Educ Psychol Rev*, 24, 369-378. doi: 10.1007/s10648-012-9205-z

Carpenter, S. K., Pashler, H., & Cepeda, N. J. (2009). Using tests to enhance 8th grade students' retention of U.S. history facts. *APPLIED COGNITIVE PSYCHOLOGY*, 23, 760-771. doi: 10.1002/acp.1507

Cepeda, N. J., Coburn, N., Rohrer, D., Wixted, J. T., Mozer, M. C., & Pashler, H. (2009). Optimizing distributed practice: Theoretical analysis and practical implications. *Experimental Psychology*, 56(4), 236-246. doi: 10.1027/1618-3169.56.4.236

Cepeda, N. J., Vul, E., Rohrer, D., Wixted, J. T., & Pashler, H. (2008). Spacing effects in learning: A temporal ridgeline of optimal retention. *Psychological Science*, 19, 1095-1102. doi: 10.1111/j.1467-9280.2008.02209.x

Cherry, K. (2019, March 11). *Psychology of turning short-term memories into long-term ones*. Retrieved from https://www.verywellmind.com/what-is-memory-consolidation-2795355

Chukharev-Hudilainen, E., & Klepikova, T. A. (2016). The effectiveness of computer based spaced repetition in foreign language vocabulary instruction: A double-blind study. *CALICO Journal*, 33(3), 334-354. doi: 10.1558/cj.v33i3.26055

Cowan, N. (2015). *Sensational memorability*. Retrieved from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sensory-memory

Craft, K. (2018, April 26). *What procedural knowledge is and how to use it*. Retrieved from https://tettra.co/article/what-procedural-knowledge-is-and-how-to-use-it/

Crane, L. (2016). *Knowledge and discourse matters*. Retrieved from https://onlinelibrary.wiley.com/doi/book/10.1002/9781119079316

Cybenko, A. K. (2011). *Interference in a modified recognition task: An evaluation of the changed-trace and multiple-trace hypotheses* (Doctoral Thesis, The University of California). Retrieved from https://escholarship.org/content/qt5zw0470p/qt5zw0470p.pdf

Davenport, T. H., De Long, D. W., & Beers, M. C. (1998). Successful knowledge management projects. *Sloan Management Review*, 39(2), 43-57. Retrieved from https://www.researchgate.net/publication/200045855_Building_Successful_Knowledge_Management_Projects

De Bruyckere, P., Kirschner, P. A., & Hulshof, C. D.(2015). *Myths about learning*. Retrieved from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sensory-memory

De la Rouviere, J. D. (2013). *Chinese radicals in spaced repetition systems: A pilot study on the acquisition of Chinese characters by students learning Chinese as a foreign language* (MPhil dissertation, The University of Stellenbosch). Retrieved from http://scholar.sun.ac.za/handle/10019.1/80325

De la Torre, J. C. (2016). *Alzheimer's turning point: A vascular approach to clinical prevention*. Retrieved from https://www.springer.com/la/book/9783319340562

Dharani, K. (2015). *The biology of thought*. Retrieved from https://www.sciencedirect.com/topics/neuroscience/episodic-memory

Druckman, D., & Bjork, R. A. (Eds.). (1991). *In the mind's eye: Enhancing human performance*. Retrieved from https://www.nap.edu/catalog/1580/in-the-minds-eye-enhancing-human-performance

Ebbinghaus, H. (1913). *Memory: A contribution to experimental psychology* (H. A. Ruger & C. E. Bussenius, Trans.). Retrieved from http://nwkpsych.rutgers.edu/~jose/courses/578_mem_learn/2012/readings/Ebbinghaus_1885.pdf. (Original work published 1885)

Eysenck, M. W., & Keane, M. T. (2015). *Cognitive Psychology: A Student's Handbook.* Retrieved from http://documents.routledge-interactive.s3.amazonaws.com/9781848724167/Chapter%206_summary.pdf

Farhadi, P. (2013). The effect of Leitner's learning box on the improvement of vocabulary teaching and learning. *Academic Discourse*. 1-15. Retrieved from http://www.globalacademicgroup.com/journals/academic%20discourse/THE%20EFFECT%20OF%20LEITNERS%20LEARNING%20BOX%20ON%20THE.pdf

Farr, M. J. (1987). *The Long-Term Retention of Knowledge and Skills: A Cognitive and Instructional Perspective*. Retrieved from https://www.springer.com/gb/book/9780387965314

Forgetting. (n.d.). Retrieval from http://psychologyrats.edublogs.org/files/2012/02/Unit_3_2012_INSJ_Theories-of-Forgetting-1612h26.pdf

Frank, T. (2018, November 14). *How to remember more of what you learn with spaced repetition.* Retrieved from https://collegeinfogeek.com/spaced-repetition-memory-technique/

Gale, T. (2006). Propositional knowledge, definition of. In *Encyclopedia of Philosophy*. Retrieved from https://www.encyclopedia.com/humanities/encyclopedias-almanacs-transcripts-and-maps/propositional-knowledge-definition

Geisler, E. (2008). *Knowledge and knowledge systems: Learning from the wonders of the mind*. Retrieved from https://www.igi-global.com/book/knowledge-knowledge-systems/670

Gemma, W. (2014, May 19). *The 6 types of knowledge: From a priori to procedural*. Retrieved from https://blog.udemy.com/types-of-knowledge/

Goddard, N. (2012). *Psychology*. Retrieved from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sensory memory

Goldstein, E. B. (2008). *Cognitive psychology: Connecting mind, research, and everyday experience* (2nd ed.). Retrieved from https://www.amazon.com/Cognitive-Psychology-second-Text-Only/dp/B004PR5PAY

Gyorbíró, N., Larkin, H., Cohen, M. (2010). Spaced repetition tool for improving long-term memory retention and recall of collected personal experiences. *Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology*, 124-125. doi: 10.1145/1971630.1971673

Hall, R. H. (1998). *Explicit and Implicit Memory*. Retrieved from http://web.mst.edu/~rhall/neuroscience/06_complex_learning/explicit_implicit.pdf

Hall, J., & Stewart, M. E. (2010). *Basic psychology*. Retrieved from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sensory-memory

Hammadi, A., & Qureishi, F. K. (2013). Relationship between the Zeigarnik Effect and consumer attention in advertisement. *World Journal of Social Sciences*, 3(4), 131-143. Retrieved from https://www.researchgate.net/publication/303990130_Relationship_between_Ziegarnik_Effect_and_Consumer_Attention

Hanks, J., & Zhan, P. (2012). The Forgetting Curve and Learning Algorithms. 53-60. Retrieved from https://pdfs.semanticscholar.org/3eda/1f89d845a893cd4c8848b41697d39af19195.pdf

Hsiao, S., & Chai, S. (2003).Multiple Memory Systems in the Brain. *Acta Neurologica Taiwanica*, 12(4), 169-176. Retrieved from https://pdfs.semanticscholar.org/b301/7b27e51570c0d9340431f410152d3db6818a.pdf

Human Memory. (2012). Retrieved from https://fr.scribd.com/document/77281558/Psychology-Chapter-7-Human-Memory

Indira Gandhi National Open University. (2017). *Knowledge: Definition, types, nature, properties and scope*. Retrieved from http://www.egyankosh.ac.in/handle/123456789/10933

Irvington Parents Forum. (2015).*Encoding and Retrieval from Long-Term Memory*. Retrieved from https://irvingtonparentsforum.files.wordpress.com/2015/05/chapter-5-encoding-and-retrieval-from-long-term-memory-edward-smith.pdf

Kandarakis, A. G., & Poulos, M. S. (2008). Teaching implications of information processing theory and evaluation approach of learning strategies using LVQ neural network. *WSEAS Transactions on Advances in Engineering Education*, 5(3), 111-119. Retrieved from http://www.wseas.us/e-library/transactions/education/2008/education-ex.pdf

Kang, S. H. K. (2016). Spaced repetition promotes efficient and effective learning: Policy implications for instruction. *Policy Insights from the Behavioral and Brain Sciences*, 3(1), 12-19. doi: 10.1177/2372732215624708

Karpicke, J. D., & Lehman, M. (2013). Human memory. In D. S. Dunn (Ed.). *Oxford Bibliographies Online: Psychology.* doi: 10.1093/OBO/9780199828340-0107

Kelley, P., & Whatson, T. (2013). Making long-term memories in minute: A spaced learning pattern from memory research in education. *Frontiers in Human Neuroscience*, 7, 589. doi: 10.3389/fnhum.2013.00589

Kensinger, E. A., & Schacter, D. L. (2016). Memory and emotion. In L. F. Barrett, M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (pp. 564-578). Retrieved from https://www.guilford.com/excerpts/barrett4.pdf?t

Knopf, M., Graf, F., & Kolling, T. (2015). *Early memory development and cultural variations*. Retrieved from https://www.sciencedirect.com/topics/computer-science/nondeclarative-memory

Kumar, R. (2014). *Research methodology: A step-by-step guide for beginners* (4th ed.). Retrieved from https://www.textbooks.com/Research-Methodology-A-Step-by-Step-Guide-for-Beginners-4th-Edition/9781446269978/Ranjit-Kumar.php

Küpper-Tetzel, C. E., & Erdfelder, E. (2012). Encoding, maintenance, and retrieval processes in the lag effect: A multinomial processing tree analysis. *Memory*, 20(1), 37-47. doi: 10.1080/09658211.2011.631550

Lally, M., & Valentine-French, S. (2011). *Introduction to psychology*. Retrieved from http://dept.clcillinois.edu/psy/IntroductionToPsychologyText.pdf

Liew, A. (2007). Understanding data, information, knowledge and their inter-relationships. *Journal of Knowledge Management Practice*, 7(2). Retrieved from https://www.researchgate.net/publication/224937037_Understanding_Data_Information_Knowledge_And_Their_Inter-Relationships

Lonergan, M. H., Brunet, A., Olivera-Figueroa, L. A., & Pitman, R. K. (2013). *Disrupting consolidation and reconsolidation of human emotional memory with propranolol*. Retrieved from https://www.sciencedirect.com/topics/neuroscience/memory-consolidation

Lotfolahi, A. R., & Salehi, H. (2016). Learners' perceptions of the effectiveness of spaced learning schedule in L2 vocabulary learning. *SAGE Open*, 6(2), 1-9. doi: 10.1177/2158244016646148

Martin, G. N., Carlson, N. R., & Buskist, W. (2010). *Psychology* (4th ed.). Retrieved from http://www.sociology.org.uk/notes/Psychology4ed.pdf

Martínez Sánchez, A. (2012). *An Open and Social Spaced Repetition System for Language Learning*. (Master thesis, The University of the Basque country). Retrieved from https://addi.ehu.es/handle/10810/10183

May, C. P., & Einstein, G. O. (2013). Memory: A five-day unit lesson plan for high school psychology teachers. Retrieved from https://www.apa.org/ed/precollege/topss/lessons/memory.pdf

McCormick, R. (1997). Conceptual and procedural knowledge. *International Journal of Technology and Design Education*, 7, 1-20. doi: 10.1023/A:1008819912213

McDermott, K. B., & Roediger, H. L. (2018). Memory (Encoding, Storage, Retrieval). In R. Biswas-Diener & E. Diener (Eds.), *General Psychology* (pp. 117-140). Retrieved from https://scholar.valpo.edu/cgi/viewcontent.cgi?article=1002&context=psych_oer

McNamee, P. (2018, November 27). *5 ways to challenge the forgetting curve*. Retrieved from https://www.learnupon.com/blog/ebbinghaus-forgetting-curve/

National Council of Educational Research and Training. (2016). *Psychology*. Retrieved from https://fr.scribd.com/document/405546368/kepy107

National Institute of Open Schooling. (2013). *Psychology*. Retrieved from http://download.nos.org/srsec328newE/328EL7.pdf

Nickson, C. (2017, October 2). *Learning by spaced repetition*. Retrieved from https://lifeinthefastlane.com/learning-by-spaced-repetition/

Pashler, H., Rohrer, D., Cepeda, N. J., & Carpenter, S. K. (2007). Enhancing learning and retarding forgetting: Choices and consequences, *Psychonomic Bulletin & Review*, 14(2), 187-193. Retrieved from http://www.pashler.com/Articles/Pashler.Rohrer.Cepeda.Carpenter_2007.pdf

Petersson, K. M. (2005). *Learning and memory in the human brain* (Doctoral Thesis, Karolinska Institutet). Retrieved from https://openarchive.ki.se/xmlui/handle/10616/38974

Pishwa, H. (Ed.). (2006). Memory and language: Introduction. In W. Bisang, H. H. Hock & W. Winter (Eds), *Trends in Linguistics Studies and* Monographs. Retrieved from https://www.bookdepository.com/Language-Memory-Hanna-Pishwa/9783110189773?ref=grid-view&qid=1552325942112&sr=1-1

Reber, P. J. (2008). *cognitive neuroscience of declarative and nondeclarative memory*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0166411508100103

Robertson, L. T. (2002). Memory and the Brain. *Journal of Dental Education*, 66(1), 29-42. Retrieved from https://pdfs.semanticscholar.org/6ba7/a86d175173ea6dbc56da62b6f002ad2593d7.pdf?_ga=2.260558862.285655618.1551988154-180401139.1550827830

Ryan, M. (2009, December 24). *Forgetting and why it* occurs. Retrieved from https://fr.scribd.com/document/24469931/Week-3

Sahoo, J., Pati, B., & Mohanty, B. (2017). Knowledge management as an academic discipline: An assessment. In B. Gunjal (Ed.), *Managing knowledge and scholarly assets in academic libraries* (pp. 99-126). Retrieved from https://www.igi-global.com/chapter/knowledge-management-as-an-academic-discipline/174326

Schwartz. B. L. (2014). *Introduction to the study of memory* (2nd ed.). Retrieved from https://us.sagepub.com/sites/default/files/upm-binaries/79654_Chapter_1.pdf

Settles, B., & Meeder, B. (2016). A trainable spaced repetition model for language learning. *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*, pages 1848–1858. doi: 10.18653/v1/P16-1174

Six ways to overcome the forgetting curve. (2017, March 22). Retrieved from https://medium.com/@CWContent/6-ways-to-overcome-the-forgetting-curve-354151c355c

Sobel, H. S., Cepeda, N. J., & Kapler, I. V. (2011). Spacing effects in real-world classroom vocabulary learning. *Applied Cognitive Psychology*, 25, 763-767. doi : 10.1002/acp.1747

Soy, S. K. (1997). *The case study as a research method*. Unpublished manuscript, University of Texas at Austin. Retrieved from http://faculty.cbu.ca/pmacintyre/course_pages/MBA603/MBA603_files/The%20Case%20Study%20as%20a%20Research%20Method.pdf

Spaced repetition. (n.d.). Retrieved from https://www.immagic.com/eLibrary/ARCHIVES/GENERAL/WIKIPEDI/W110427S.pdf

Spaced repetition and MemoryLifter. (2008). Retrieved from http://www.memorylifter.com/fileadmin/press/spaced_repetition.pdf

Spacey, J. (2017, February 23). *What is propositional knowledge?* Retrieved from https://simplicable.com/new/propositional-knowledge

Spielman, R. M. (2017). *Psychology*. Retrieved from https://cnx.org/exports/4abf04bf-93a0-45c3-9cbc-2cefd46e68cc@8.1.pdf/psychology-8.1.pdf

Stenmark, D. (2001). The relationship between information and knowledge, In S. Bjørnestad (Ed.), *Proceedings of IRIS 24* (pp. 11-14). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.21.965

Tabibian, B., Upadhyay, U., De, A., Zarezade, A., Schölkopf, B., & Gomez-Rodriguez, M. (2018). Optimizing human learning. Retrieved from https://arxiv.org/abs/1712.01856

Ten Berge, T., & Van Hezewijk, R. (1999). Procedural and declarative: An evolutionary perspective knowledge. *Theory & Psychology*, 9(5), 605-624. doi: https://doi.org/10.1177/0959354399095002

Teninbaum, G. H. (2017). Spaced repetition: A method for learning more law in less time. *Journal of High Technology Law*, 17(2), 273-312. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2893239

Thalheimer, W. (2006). *Spacing learning over time*. Retrieved from http://www.phase-6.com/system/galleries/download/lernsoftware/Spacing_Learning_Over_Time__March2009v1_.pdf

Theory of Knowledge. (n.d). Retrieved from http://sociology.morrisville.edu/readings/STS101/Philosophy-TheoryOfKnowledge%20-%20flattened.pdf

The science behind spaced repetition. (2016, May 11). Retrieved from https://blog.wranx.com/the-science-behind-spaced-repetition

Troedson, T. (2009). *On the difference between knowledge and understanding*. Retrieved from http://www.milinstitute.se/pub/arkiv/T_Troedson_paper.pdf

Tulving, E. (1985). How Many Memory Systems Are There? *American Psychologist*, 40(4), 385-398. Retrieved from http://www.bryanburnham.net/wp-content/uploads/2014/01/Tulving-1984-How-Many-Memory-Systems-Are-There.pdf

Tulving, E. (1991). Interview with Endel Tulving. *Journal of Cognitive Neuroscience*, 3(1), 89–94. Retrieved from http://alicekim.ca/Interview.pdf

Williams, Y. (n.d.). *Retrieval cues: Definition & examples*. Retrieved from https://study.com/academy/lesson/retrieval-cues-definition-examples-quiz.html#lesson

Windarp, J. (2015). *Usability and learning potential of virtual learning environments which applies spaced repetition: A case study on sharplet.com* (Master thesis, The University of Stockholm). Retrieved from https://pdfs.semanticscholar.org/aa67/90b0101193285b5241393d6baf2704ce1737.pdf

Wittman, J. (n.d.). *The forgetting curve*. Retrieved from https://www.csustan.edu/sites/default/files/groups/Writing%20Program/forgetting_curve.pdf

Wixted, J. T. (2004). The psychology and neuroscience of forgetting. *Annual Review of Psychology*, 55, 235-269. doi: 10.1146/annurev.psych.55.090902.141555

Wozniak, P. (2014, January 2). *Piotr A. Wozniak, Biodata*. Retrieved from https://www.supermemo.com/en/archives1990-2015/english/company/wozniak

Yang, W., Jin, L., Tao, D., Xie, Z., & Feng, Z. (2016). DropSample: A new training method to enhance deep convolutional neural networks for large-scale unconstrained handwritten Chinese character recognition. *Pattern Recognition*, 58. doi: 10.1016/j.patcog.2016.04.007

Yeager, L. B. (2005). Why distinguish between information and knowledge? *Econ Journal Watch*, 2(1), 82-87. Retrieved from https://econjwatch.org/File+download/78/2005-04-yeager-sympos.pdf

Appendices

Appendix 1: Students' Questionnaire

Students' Questionnaire

Dear Students,

This questionnaire aims at collecting data for the sake of conducting a master research study about the use of spaced repetition technique in enhancing long-term propositional knowledge retention. You are; therefore, kindly invited to answer the following questions. Please, answer this questionnaire by ticking (✓) in the corresponding box (es) and provide a full statement whenever necessary.

Thanks in advance for your time and collaboration

Key terms:

Propositional (factual) knowledge: is the knowledge that carries the answer of W_h questions; for example, to know that '**Discourse Analysis** is the area of linguistics that refers to the analysis of language in use beyond a sentence in a real life situation'.

Spaced repetition technique: is a learning technique in which learners repeat what they want to memorize as information many times distributed over many revision sessions. For example, revising the information today, then after a week, then after two weeks and so on in order to improve long-term memorization. In other words, to repeat the information in many revision sessions spaced by time intervals rather than repeat it in a single session).

Radja HERZALLAH

Email: radjaherzallah@gmail.com

Mohamed Kheider University of Biskra

Faculty of Letters and Foreign Languages

Department of Foreign Languages

Section of English

Section One: Students' Prior Experiences with Propositional Knowledge Retention

1. Is passing the examinations your only goal behind memorizing information?

a. Yes ☐ **b.** No ☐

- If 'No', please specify other goals

……

……

2. Which type of these two types of knowledge are you more likely to remember?

a. Factual knowledge (see its definition above) ☐

b. Terminology ☐

3. In order to revise a material for the examination, do you revise it:

a. From time to time ☐

b. Just the day before the examination ☐

c. I do not revise it. Rather, I depend on what I received as information during the lecture ☐

4. How long do you often retain (keep in memory) what you have learned as factual knowledge before forgetting it?

a. Few hours ☐

b. Few days ☐

c. Few months ☐

d. One year ☐

e. More than one year ☐

5. During the examination, do you encounter any difficulties in recalling what you have revised?

a. Yes ☐ **b.** No ☐

- If ‘yes’, what do you think is the reason (s) behind this inability (You may choose more than one option).

  a. Lack of preparation for the examination ☐

  b. Lack of concentration during the revision session ☐

  c. Overlap of information with each other (old information with recent one) ☐

  d. The big amount of information you should memorize ☐

  e. Other reasons:

  ……

  ……

6. How much acquired information do you usually recall during the examination?

  a. Less than 30% of what I have revised ☐

  b. 30% - 50% ☐

  c. 50% - 70% ☐

  d. 70% - 90% ☐

  e. I remember all what I have revised ☐

7. Do you use any techniques to help you improve your memory and your recall later?

  a. Yes ☐ **b.** No ☐

- If ‘yes’, which technique (s) do you use? (You may choose more than one option).

  a. Ask questions about the information I want to memorize ☐

  b. Use schemas and mind maps ☐

  c. Link the to-be-revised information with your prior knowledge ☐

  d. Relate the information you want to memorize to your personal life ☐

  e. Repeat the information until you memorize it ☐

  f. Summarize the information in your own words ☐

  g. Talk out loud and pretend that you are a professor ☐

h. Other techniques:

……

……

8. Do you agree that in order to retain the acquired information you have to be tested about it?

a. Strongly agree ☐ **b.** Agree ☐

d. Disagree ☐ **d.** Strongly Disagree ☐

- Whatever your answer, please justify it

……

……

……

Section Two: Students' View towards Knowledge Retention

1. To what extent do you think that forgetting what you learned as knowledge can affect your learning?

a. To a great extent ☐

b. To some extent ☐

c. To a very little extent ☐

- How?

……

……

2. Do you think that protecting your learned knowledge from fading (disappearing) is a necessity even after your graduation?

a. Yes ☐ **b.** No ☐

- If ‘yes’, why?

……

……

……

Section Three: Students’ Perception towards Spaced Repetition Technique

1. Have you ever heard of spaced repetition technique for better memorization? (see its definition above)

a. I have never heard of it before now ☐

b. I know it but not under this name ☐

c. I know it ☐

2. For those who apply the spaced repetition technique, how often do you apply it?

a. Always ☐

b. Sometimes ☐

c. Rarely ☐

3. In applying the spaced repetition technique, do you revise what you learned?

a. Weekly ☐

b. Monthly ☐

c. Yearly ☐

4. If you have tried this technique before, are you satisfied with the efficiency of using spaced repetition technique in enhancing your knowledge retention?

a. Yes ☐ **b.** No ☐

- If ‘No’, why?

……

……

Section Four: Further Suggestions

If you have any suggestions about the use of spaced repetition technique in improving long-term propositional knowledge retention, please propose them below

……

……

……

……

Thank you for your kind cooperation

Appendix 2: The Opinionnaire

Opinionnaire

1. How did you find the questions in general?

……

……

……

2. Have you noticed that any of the questions seems to be strange or unusual?

a. Yes ☐ **b.** No ☐

- If 'yes', please specify which question (s)

……

……

……

3. Have you found any questions needless or should be omitted?

a. Yes ☐ **b.** No ☐

- If 'yes', please specify which question (s)

……

……

……

4. Have you noted any questions that are unnecessarily repeated in which they targeted the same thing?

a. Yes ☐ **b.** No ☐

- If ‘yes’, please specify which question (s) you think they are repeated

……

……

……

5. Have you detected any mistakes in terms of grammar, spelling, or punctuation?

a. Yes ☐ **b**. No ☐

- If ‘yes’, please specify them

……

……

……

6. What do you think of the order of questions?

……

……

7. If you have any suggestions to help us improve this questionnaire in terms of introduction and questions, please write them down below

……

……

……

Thank you for your kind cooperation

Appendix 3: Memory Trainers' Interview

Memory Trainers' Interview: The Arabic Version

الأسئلة:

س1: برأيك، ما هي أهم الأسباب الكامنة وراء ظاهرة النسيان لدى المتعلمين؟

س2: كيف تقيّم تقنية التكرار المتباعد لتحسين الاحتفاظ طويل الأمد بالمعرفة و تعزيز الاستذكار؟

س3: على من طبّقتم هذه التقنية من قبل؟

س4: كم تراوحت أعمار الأشخاص الذين تم تطبيق تقنية التكرار المتباعد عليهم؟

س5: ما هو نوع المعرفة الذي تم استهدافه عند تطبيق هذه التقنية؟

س6: كيف كانت آلية تطبيق هذه التقنية؟

س7: كيف كان انطباع الأشخاص الذين طُبّقت عليهم هذه التقنية حول كفاءتها؟

س8: ما هي عيوب تقنية التكرار المتباعد إذا كانت موجودة؟

س9: هل لديك أي اقتراحات تساعد في تطبيق هذه التقنية؟

شكرا جزيلا على تعاونكم

Appendix 4: Memory Trainers' Interview

Memory Trainers' Interview: The English Version

The Questions:

Q1: In your opinion, what are the main causes behind forgetting among the learners?

Q2: How do you find the efficiency of the spaced repetition technique in improving long-term knowledge retention and enhancing the recall?

Q3: With whom did you apply this technique?

Q4: How old were these trainees?

Q5: Which type of knowledge did you target in applying this technique?

Q6: How was the mechanism of applying this technique?

Q7: How was the impression of the trainees of the efficiency of this technique?

Q8: What are the disadvantages of the spaced repetition technique in your opinion?

Q9: Do you have any suggestions that help in applying this technique?

Thank you for your kind cooperation

الملخّص

هدفت الدراسة الحالية إلى استقصاء فعاليّة استعمال تقنية التكرار المتباعد لتحسين الاحتفاظ طويل الأمد بالمعرفة الافتراضية. كما سعت هذه الدراسة أيضا إلى استكشاف ما إذا كان الطلاب واعين بأهمية حمايتهم لمعارفهم المكتسبة بعد اجتيازهم الاختبارات و حتى بعد تخرجهم. لتحقيق هذه الأهداف تم استعمال أداتين لجمع البيانات و التي تمثّلت في استبيان موجّه لطلاّب الماستر لغة انجليزية بجامعة محمد خيضر، بسكرة، الجزائر، إضافة إلى مقابلة شفهية مع مدرّبي الذاكرة من عدة بلدان. و قد أظهرت النتائج أن الطلاّب غير واعين بشكل كبير بأهمية حماية ما تعلّموه من معرفة بما أنّ هدف غالبيتهم الوحيد من خلال المراجعة هو اجتياز الاختبارات. كما أشارت النتائج إلى أنّ تقنية التكرار المتباعد تساعد الطلاب إلى حد كبير في تخفيف النسيان و تحسين الاحتفاظ طويل الأمد بالمعرفة الافتراضية.

الكلمات المفتاحية: الاحتفاظ طويل الأمد بالمعرفة، التكرار المتباعد، المعرفة الافتراضية