Improving Persian-English Vocabulary Learning Through a Learning Strategy Instruction Embedded in a Purpose-built Web Application

By

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Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person, except where due reference is made in the text.

Signed and dated:

12/04/2022

Siamak Mirzaei

Dedication

To the greatest blessings of my life:

To the memory of my dad, Mohammad Esmaeil Mirzaei

who unfortunately passed away on the 7th of July 2016, not giving me the chance to tell him that his wishes for me are finally coming true.

To my mom, Maryam, my brothers, Arash and Saber, and my partner Shaghayegh.

Your support, encouragement, and constant love have sustained me throughout my life and successfully made me the person I am becoming. Thank you!

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Firstly, I acknowledge and pay my respects to the Kaurna people, the traditional custodians whose ancestral lands I gather on. I acknowledge the deep feelings of attachment and relationship of the Kaurna people to country, and respect and value their past, present and ongoing connection to the land and cultural beliefs.

Secondly, I would like to thank my supervisors, Dr Trent Lewis, Dr Mirella Wyra, and Dr Brett Wilkinson, whose expertise and support were invaluable. Your insightful feedback pushed me to sharpen my thinking and brought my work to a higher level.

Finally, I would like to thank all my friends for their wise counsel and sympathetic ear. You are always there for me.

Abstract

Learning new vocabulary is one of the challenges in language learning yet crucial for mastering another language. It is also essential in any discipline or professional field where mastering new terminology is indispensable. **VLASTWA** is a **V**ocabulary **L**earning **a**nd **S**trategy **T**eaching **W**eb **A**pplication designed to help Persian native speakers improve their English vocabulary knowledge. In this study, I examined the effects of VLASTWA's use on improving Persian learners' vocabulary. The conducted research presents an evaluation of efficacy and usability of this custom-built (for this project), targeted and learnable web application for teaching an extensively researched vocabulary learning strategy, the keyword method, and for facilitating learning of new vocabulary with the aid of this method. In this longitudinal study (n = 240, age 18+), effectiveness of the use of the keyword method taught within the designed web application (app) or traditional pen and paper (P&P) was compared between four experimental (two P&P and two app groups – with differences in receiving the encoding or encoding and recall keyword method training) and two control groups (one app and one P&P). In the experimental groups, participants learned to use the keyword method, applied it in learning 22 new (English) words, and tested the recall of this newly learned vocabulary within the app and P&P methods on four different occasions (times) while in the control groups – the only difference was not being given any keyword method instruction.

The usability of the web application utilised in the app methods was evaluated through a system usability scale (SUS) questionnaire, which is an industry standard tool to evaluate the usability of software systems.

The findings show that the web application was a preferred method in all groups and an effective tool in learning new vocabulary with average 72% vocabulary recall in word-set 1 and 76% in word-set 2. The findings highlight how the interactive and meaningful VLASTWA can complement and enhance the learning of second/foreign language vocabulary. However, as this is the first investigation of its kind, future design, development, and experimental studies are required to maximise the potential use of the designed web application for future experimental studies with different populations of young children to adults, disparate word-sets/languages, and different

delivery and measurement technologies (augmented, virtual reality, and electroencephalogram).

Keywords: keyword method, explicit strategy instruction, human–computer interaction, computer assisted language learning, usability testing.

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GLOSSARY

The following abbreviation and technical terms were used in this thesis:

ANOVA: Analysis of Variance

Apache: a free open source widely used web server software

AR: Augmented Reality

CALL: Computer Assisted Language Learning

CASLA: Computer Assisted Second Language Acquisition

CELL: Computer Enhanced Language Learning

CLT: Cognitive Load Theory

CSE: College of Science and Engineering

CSS: Cascading Style Sheets

DBMS: Database Management System

DCA: Dual Channel Assumption

ECL: Extraneous Cognitive Load

EdTech: Education Technology

EEG: Electroencephalogram

EFL: English as a Second Language

e-learning: Learning via the use of electronic media, most commonly the Internet

ERD: Entity Relationship Diagram

ERPs: Event-Related Potentials

ESL: English as a Foreign Language

FL: Foreign Language – in this study, as FL is appropriate for the participants' situation (where they are learning English as a foreign language), FL and Second Language (L2) are used in the literature interchangeably for clarity of writing

fMRI: functional Magnetic Resonance Imaging

FRAME: Framework for the Rational Analysis of Mobile Education

GCL: Germane Cognitive Load

GNU General Public License: a series of widely used free software licenses that guarantee end users the freedom to run, study, share, and modify the software

HCI: Human–Computer Interaction

HTML: Hyper Text Mark-Up Language

ICL: Intrinsic Cognitive Load

ICT: Information and Communications Technology

IDE: Integrated Development Environment

iOS: iPhone Operating System

IT: Information Technology

JavaScript: A text-based programming language used both on the client side and server side that allows you to make web pages interactive

JSON: JavaScript Object Notation

KWM: Keyword Method

L1: First Language

LMS: Learning Management System

LTSC: Learning Technology Standards Committee

MALL: Mobile Assisted Language Learning

M-learning: Mobile Learning

MOOC: Massive Open Online Course

MySQL: A relational database management system based on SQL

NLP: Natural Language Processing

PC: Personal Computer

P&P: Pen and Paper

PhD: Doctor of Philosophy

PHP: Hypertext Pre-Processor

phpMyAdmin: A free web application that provides a convenient GUI for working with the MySQL database management system

RDBMS: Relational Database Management System

RQ: Research Question

SQL: Structured Query Language

SQuaRE: Systems and software product Quality Requirements and Evaluation

SSL: Secure Socket Layer

SUS: System Usability Scale

TALL: Technology Assisted Language Learning

TELL: Technology Enhanced Language Learning

UI: User Interface

UX: User Experience

Voice Over Internet Protocol: VOIP

VLASTWA: Vocabulary Learning and Strategy Teaching Web Application

VR: Virtual Reality

WWW: World Wide Web

XAMPP: A free and open-source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, MariaDB database, and interpreters for scripts written in the PHP and Perl programming languages

1 INTRODUCTION

In Iran, it is expected that students in the tertiary education study English. This is a challenge especially given the big differences between English and Persian (e.g., sounds, letters). One of the important tasks in learning English is mastering vocabulary. A typical method for learning new words is rote learning. Rote learning is the preferred method reported by many learners while less effective than the keyword method (KWM) as shown in the literature. The KWM, extensively researched and found to be useful in the alphabetic languages' strategy; however, very little has been reported about the KWM use in the context of Persian-English vocabulary learning and became of interest for this study. The focus of this thesis is to report the evaluation of efficacy and usability of the custom-built web application for: a) teaching an extensively researched vocabulary learning strategy, the KWM; facilitating learning of new Persian-English word-pairs with the aid of the KWM.

In this chapter, the thesis statement (section 1.1) presents the research problem (section 1.1.1) and the research significance and focus (section 1.1.2). Next, a brief overview of the thesis structure (section 1.2) and the published work during the PhD candidature (section 1.3) are presented. The chapter summary is provided in section 1.4.

1.1 Thesis Statement

1.1.1 Research Problem Description

One of the most crucial components of foreign language (FL) learning is vocabulary learning. Vocabulary learning is crucial as the FL learner undertakes a lot of vocabulary building tasks at the early stages of learning (McCrostie, 2007; J. C. Richards, 1976). Vocabulary learning plays an important role in FL comprehension as 70–80% of FL comprehension is based on vocabulary learning (Nagy et al., 2000). Vocabulary learning, crucial for FL proficiency, takes place over a long period of time with restricted contact time in formal education contexts (e.g., classrooms). The vocabulary learning is often seen as students' responsibility to learn in their own time. Students who employ effective self-regulation of learning and use effective learning strategies have greater learning success (B. J. Zimmerman & Schunk, 2001). This is also the case in vocabulary learning (Macaro, 2006). However, many learners require

support for effective self-regulated vocabulary learning because of lack of strategy knowledge for target word and its meaning (word-pair) learning (Barcroft, 2009). Additionally, vocabulary learning is more challenging for learners who tend to learn a new writing system (Hamada & Koda, 2008), such as learning English vocabulary as a native Persian speaker.

One way of enhancing vocabulary building is the use of learning strategies to promote efficient vocabulary learning (Folse, 2012) while encouraging autonomous and self-regulated learning practices. Oxford (1990a) defined learning strategies as techniques used for promoting learning by helping the learner in learning processes. Many researchers consider learning strategies as an effective element in designing effective instructions (e.g., Cheng, 2011; Lee et al., 2010). With some learning strategies, learners link new information to prior knowledge to make the new information meaningful (Oxford, 1990). For an effective outcome with learning strategies, it is important to include the strategy along with the material to be learnt since mere presentation of the material and the strategy independently does not have the same impact (Mergel, 1998). Also, the learner must be directed in using the prescribed strategy while limiting the use of a number of strategies all at once (Pressley, 1990). Among learning strategy types, encoding strategies are one of the most researched types (e.g., Delaney & Verkoeijen, 2009; Gentner et al., 2003). According to Pressley and Hilden (2006), in encoding strategies, efficient recall of required stored information in long-term memory is due to how the learners create mental associations and connections with previous knowledge. The KWM, which is a mnemonic learning strategy, is effective in improving vocabulary learning (Atkinson & Raugh, 1974; Carney & Levin, 1998; Ott et al., 1973). However, some researchers believe that the KWM is only helpful in lower levels of learning (e.g., comprehension of vocabulary) where the learning tasks are less complicated – a perspective based on Bloom's learning taxonomy (e.g., Siegel & Shaughnessy, 1994; Worthen & Hunt, 2011). On the other hand, many scholars disagree and believe that the KWM can facilitate higher-order learning (e.g., illustrating the difference between words) (Carney & Levin, 2008).

When designing instructions, two important components to consider are incorporating learning strategies with the material to be presented and being informed about learner characteristics such as their prior knowledge (Morrison et al., 2007). Another point to

consider is the cognitive load associated with the instructions in learning strategies. In training of complex cognitive tasks, the presented information to learners should be balanced while the cognitive load is neither overwhelming nor underwhelming (Paas & Van Merriënboer, 1994). Balanced cognitive load is a key factor in achieving maximum performance (Kyndt et al., 2010). In the current study, these instruction design principles were applied to

a) learning vocabulary via a vocabulary learning strategy (the KWM) and
b) learning how this strategy (the KWM) was utilised within the technology-based environment (the developed web application).

Utilising technology in FL education has increased significantly leading to the instigation of the computer assisted language learning (CALL) field (Blake, 2013; Lin et al., 2016; Warschauer, 2004). One of the major reasons for CALL's gradual growth in recent decades is computer/technology affordances in language learning (e.g., contextuality, informality, pervasiveness, personalisation, ubiquity, and portability) (Kukulska-Hulme, 2009). Specifically, in the current research study, technology affordances in language learning were utilised to investigate the usability, applicability, and learnability of a web application designed for teaching a vocabulary learning strategy and utilising that strategy in a CALL-based environment for vocabulary learning and testing. The current study aimed to evaluate the efficacy of technology usage to augment vocabulary learning with use of the KWM as a sound learning strategy for vocabulary learning. Although many prior research studies in FL vocabulary learning have been conducted, very little research exists specifically assessing Persian native learners' English vocabulary learning experience and recall on a set number of words. The current study aimed to fill this gap via

a) teaching a mnemonic learning strategy (the KWM) and
b) utilising this strategy in a technology-based environment (a web application) for vocabulary learning and testing.

Many research studies have utilised the KWM in learning target words from a language with orthographical, phonological, and syntactical similarities (e.g., English learners learning Spanish in Wyra & Lawson's (2018) study). It is worth pointing out that Persian

language has few phonological and syntactical and no orthographical similarities with English (and other Latin or Germanic languages) (Navehebrahim, 2012).

1.1.2 Research Significance and Focus

Many research studies in human–computer interaction (HCI) discussed how the adapted technology could be a usable medium for vocabulary learning in FL in different contexts such as location-informed, passive, collaborative mobile games, and instant messaging vocabulary leaning systems (e.g., Culbertson et al., 2017); however, few studies focused on usability and vocabulary learning strategy (e.g., Liu, 2014). The search to find a research study that focused on usability, vocabulary learning strategy, and vocabulary learning strategy instruction has not yielded any findings except for Mirzaei's (2016) study.

There have been numerous research studies focusing on the use of learning strategies in FL vocabulary learning, and on the use of the KWM in particular (e.g., Beaton et al., 1995; Lawson & Hogben, 1998; Pressley et al., 1980). However, as only a few research studies examined the use of the KWM for learning Persian–English word-pairs (e.g., Davoudi & Yousefi, 2016; Toghyani Khorasgani & Khanehgir, 2017), and specifically in a technology-based environment (e.g., Esmaeili & Shahrokhi, 2020), this study attempted to contribute to the growing body of knowledge in this area.

The search to find an application that teaches the KWM vocabulary learning strategy and utilises it in KWM vocabulary learning has not yielded any findings except for Mirzaei's (2016) study. Some studies utilised the traditional KWM (or similar mnemonic strategies) in a technology-based environment (Godwin-Jones, 2010; Sommer & Gruneberg, 2002); however, partial or no explicit instruction of the KWM was considered within the application environment. As a result, in the current study, a technology-based environment (web application) with two modules was designed. The first module was the training module to

a) teach the KWM strategy with a focus on explicit strategy instruction requirements of the KWM and
b) provide a demonstration of the web application usage.

The second module focused on Persian–English vocabulary learning and testing. For usability testing, the industry standard SUS assessed the usability of the designed web application (System Usability Scale (SUS) | Usability.Gov, 2018).

English vocabulary learning is essential for Persian learners as learners are required to pass English tests that focus heavily on English vocabulary during schools years for the university entrance examination, and during university studies (Akbari, 2015; Jahangard, 2007; Zohrabi et al., 2012). However, other scholars counted using the Internet appropriately, meeting people from other cultures, and future career development as primary reasons for English (vocabulary) learning in Iran (e.g., Vaezi, 2008). Dashtestani (2016) reported Iranian learners' positive attitude towards learning English vocabulary via technology. Similarly, Khabiri and Khatibi (2013) considered mobile devices as effective tools for Iranian FL learners' vocabulary learning (Khabiri & Khatibi, 2013) and Alavinia and Qoitassi (2013) discussed how mobile devices could be an effective tool for vocabulary learning for Iranian learners. Furthermore, Dashtestani (2016) discussed the lack of learning strategies in technology-based vocabulary learning in Iran.

From my own personal journey as an Iranian FL learner, while vocabulary learning takes a significant amount of time, the emphasis on vocabulary learning in Iran is still on transmissive learning and teaching and repetition rather than teaching learners self-regulation strategies. My personal reason to pursue research in this field has been my passion and interest in learning efficiently through technology and effective learning strategies. After gaining some knowledge about the KWM in my graduate diploma in research methods degree at Flinders University (Mirzaei, 2016), I conducted a thorough investigation through my PhD journey in this field to discover whether a technology-based environment with a sound underlying vocabulary learning strategy is available for English–Persian vocabulary learning. My quest for identifying such research studies/platforms did not yield any findings. Few of these research studies covered English–Persian vocabulary learning via technology (e.g., applications) of which none utilised a learning strategy (e.g., the KWM) along with explicit instruction or did not employ the technology appropriately. For instance, some scholars utilised vocabulary learning via technology in English vocabulary learning for Persian speakers primarily via pre-built platforms (e.g., social networking applications), which

are not built for vocabulary learning purposes (e.g., WhatsApp or Telegram) and lack learning strategies and explicit instructions features (e.g., Ghobadi & Taki, 2018; Hashemifardnia et al., 2018). Therefore, I decided to fill this gap via developing and evaluating a web application called VLASTWA (**V**ocabulary **L**earning **a**nd **S**trategy **T**eaching **W**eb **A**pplication) for English vocabulary learning and vocabulary recall testing utilising a mnemonic learning strategy (the KWM) for Persian native speakers.

This research study targeted going beyond the tool for content delivery and looking at learning outcomes. The aim was to design and test a web application that can contribute to learners' declarative and procedural knowledge through pedagogically sound steps. This study investigates the use of technology for explicit vocabulary learning strategy instruction and vocabulary learning and testing by

1. Teaching step-by step how to use the mnemonic KWM to learn new words and their meanings.
2. Modelling the use of the KWM on examples.
3. Providing opportunities for guided practice.
4. Incorporating independent learning of new vocabulary.
5. Providing means for learners to test their learning.
6. Utilising a web application environment that can encourage enjoyment and fun of learning.

This research focused on providing solutions for learning new vocabulary. As the learning strategy, the KWM was the focus and was implemented in a technology-based setting.

This study was framed within the scope of vocabulary acquisition/learning of FL learners' short and long-term retention through implementing a longitudinal experimental study design.

One of the main aims of this research study was to investigate the use of CALL or mobile assisted language learning (MALL) for vocabulary learning and teaching, particularly with the use of VLASTWA (the web application) as a resource with the KWM embedded in the application. The focus was mainly on web-based technologies as the Internet is a widespread technology and an important tool for communication and a venue for experiencing other cultures (Nim Park & Son, 2009). Some

researchers have already indicated that students are more motivated to use CALL when they are interested in it (e.g., Barrs, 2012; Gillespie & McKee, 1999).

1.2 Thesis Structure

The thesis consists of five chapters. In the 'Introduction', research problem, research significance, the thesis structure, and the publications during the candidature are presented. In Chapter 2, the literature review and background studies are presented. Chapter 2 includes

a) vocabulary learning importance, self-regulation, learning strategies with a focus on the KWM, memory and learning processes, strategy instruction, and cognitive load,
b) CALL/MALL including its use in vocabulary learning, challenges, effectiveness, learning theories and CALL, and CALL usage among Persian learners,
c) theoretical frameworks including Koole's Framework for the Rational Analysis of Mobile Education (FRAME) (Koole, 2006, 2009; Koole & Ally, 2006) and Ma's memory-based strategic model (Ma, 2014, 2017),
d) strategy instruction in CALL,
e) the web application including the software architecture design, prototyping, usability, and user experience (UX), user interface (UI), and user interaction design, and
f) research questions (RQs).

Chapter 3 presents the research methods including

a) methodology and study design of the experimental study components 1, 2, and 3,
b) participants,
c) procedures,
d) study design and RQs relevance,
e) materials and tools,
f) data collection and data analyses methods, and
g) data preparation.

Chapter 4 presents the web application usability and vocabulary recall data analyses and findings.

Chapter 5 presents the discussions and conclusions by summarising contributions of the work undertaken in this thesis, and study limitations and implications for further research.

A list of references and appendices are available after Chapter 5 while the glossary is provided before Chapter 1.

Although this is an interdisciplinary thesis in Educational Technology (EdTech), focusing on the use of technology for learning purposes, as it is submitted to the College of Science and Engineering (CSE), submission requirements such as thesis length and structure are based on CSE requirements. The design, development, and testing of the web application is considered as of part of this PhD research project as it contributed to the core element and the tool to enable the present research study.

1.3 Publications

The following peer-reviewed research outputs were published and presented during this Doctor of Philosophy (PhD) candidature and stemming from the research reported in this thesis

1. Mirzaei, S., & Hayati, A. F. (2018). Effects of the computer mediated communication interaction on vocabulary improvement. Telkomnika, 16(5), 2217-2225.
2. Mirzaei, S., Wilkinson, B., & Wyra, M. (2018). Usability testing of VLASTA: a vocabulary learning and strategy teaching app. In 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE) (pp. 685-689). IEEE (based on Mirzaei, S. (2016). Evaluating efficacy and usability of mobile devices for learning new words. Dissertation, Flinders University, School of Computer Science, Engineering and Mathematics).
3. Mirzaei, S., Lewis, T., Wyra, M., & Wilkinson, B. (2019). VLASTWA: A Vocabulary Learning and Strategy Teaching Web App. Poster session presented at The Research on Teaching and Learning Conference at McMaster University, Hamilton, Ontario, Canada.

4. Mirzaei, S., Lewis, T., Wyra, M., & Wilkinson, B. (2020a). Usability Testing of VLASTWA: A Vocabulary and Strategy Teaching Web App. In 32nd Australian Conference on Human-Computer Interaction (pp. 614-621).
5. Mirzaei, S., Lewis, T. W., Wyra, M., & Wilkinson, B. (2020b). VLASTWA: a vocabulary learning and strategy teaching web-app. CALL for widening participation: short papers from EUROCALL 2020, 240.

1.4 Chapter 1 Summary

In Chapter 1, initially the research problem was described by discussing vocabulary learning, role of vocabulary mastery in FL proficiency, importance of learning strategies and strategy instruction, and the KWM. Then, the research significance was discussed indicating that one of the primary goals of this research was to explore the usage of CALL/MALL for vocabulary learning and teaching of Persian native speakers, via utilising the KWM embedded in the web application designed for this research study. The focus was mostly on web-based technologies, as the Internet is a widely used technology that serves as a means of contact and exposure to various cultures. Finally, the thesis structure and works published during the time of the candidature were highlighted. The next chapter reviews the literature on vocabulary learning (section 2.1), CALL/MALL (section 2.2), theoretical frameworks utilised for this research study (section 2.3), learning strategy instruction in CALL with a focus on the KWM (section 2.4), and the web application (section 2.5). Then, the RQs are presented (section 2.6). The background studies on the KWM (section 2.1.3.1) are covered under the vocabulary learning section (section 2.1).

2 LITERATURE REVIEW

This chapter investigates, in details, the background relevant to this research study including substantive findings as well as theoretical and practical contributions.

The first section of this chapter (section 2.1) discusses vocabulary learning including vocabulary importance, self-regulation, learning strategies with a focus on the KWM (section 2.1.3.1), memory and vocabulary learning processes and retention, strategy instruction, and cognitive load. In the next section (section 2.2), background studies on CALL including CALL and vocabulary learning, CALL challenges, CALL effectiveness, relevant learning theories and CALL, and CALL use among Persian learners are presented. In the next section (section 2.3), the theoretical frameworks including the Framework for the Rational Analysis of Mobile Education (FRAME) (Koole, 2006, 2009; Koole & Ally, 2006) and memory-based strategic model (Ma, 2014, 2017) are discussed. Then, literature on learning strategy instruction in CALL with a focus on the KWM (section 2.4), and the web application including the software architecture design, prototyping, usability, and user experience (UX), user interface (UI) and user interaction design (section 2.5) are presented. The RQs and chapter summary are available in sections 2.6 and 2.7, respectively.

2.1 Vocabulary Learning

Vocabulary learning importance, self-regulation, learning strategies including the KWM, and effectiveness of the KWM along with strategy instruction and cognitive load are discussed in this section.

2.1.1 Importance

Vocabulary mastery in learning a language is an important factor in the learners' knowledge area (Cameron, 2001; Nation & Webb, 2011). Linse and Nunan (2005) considered learners' vocabulary development as a crucial part of their language development journey. Researchers in different language learning fields have increasingly been attending to vocabulary learning (Arnaud & Béjoint, 1992; Carter & McCarthy, 2014; Coady & Huckin, 1997; Leech, 1991; Schmitt, 1997).

Schmitt (2008) considered knowledge of vocabulary as one of the main factors necessary for mastering another language. Lomicka (1998) stated that FL learners

should reach a certain vocabulary threshold so that they can develop linguistic abilities. Gass (1999) and Zhang and Li (2011) pointed out that the lack of learners' required fundamental vocabulary knowledge can negatively affect mastering the four language skills of listening, reading, writing, and speaking. Additionally, according to Nation (1993), "vocabulary knowledge enables language use, language use enables the increase of vocabulary knowledge, and knowledge of the words enables the increase of vocabulary knowledge and language use and so on" (Nation, p. 6). Nation and Webb (2011) considered vocabulary learning vital for all English language skills of speaking, reading, writing, and listening while Nunan (1991) considered language learning impossible without proper and adequate vocabulary acquisition. Lack of vocabulary knowledge results in inability in utilising FL functions and structures (Nunan, 1991), which is one of the primary challenges in language learning (Huckin, 1995).

Although vocabulary learning strategies, strategy instruction, and self-regulated learning of Persian learners have been investigated widely, few research studies (e.g., Kavani & Amjadiparvar, 2018; Zarrabi, 2017) were published in high-quality journals. Similarly, English as a Foreign Language (EFL) Persian learners' usage of CALL/MALL for vocabulary has been a popular research area among scholars; however, few research studies (e.g., Ebadi et al., 2018; Ebadi & Ghuchi, 2018) are represented in high quality peer-reviewed publications. Furthermore, Persian FL vocabulary learning via the KWM is well-researched area with considerable number of acceptable publication (e.g., Baleghizadeh & Ashoori, 2010; Davoudi & Yousefi, 2016; Piribabadi & Rahmany, 2014; Taheri & Davoudi, 2016; Tavakoli & Gerami, 2013). However, none of the discussed (and investigated) aforementioned literature tested the use of a web application (CALL usage) for teaching a strategy (the KWM) and utilising that strategy for FL vocabulary learning and testing for Persian native speakers for English vocabulary learning.

2.1.2 Self-Regulation

Learners' interaction with the language is usually limited to the classroom or learning environment. This lack of exposure to the language learning environment outside classroom makes it reasonable to propose that vocabulary learning should be relegated to learners' own time, before/after class learning. As stated by Oxford

(1999), self-regulation includes efficient learning strategy use, facilitating learning purposes, effective performance, and time management. Research demonstrates that self-regulated learners achieve better learning outcomes (B. J. Zimmerman & Schunk, 2001), while possibly requiring some support to achieve effectiveness in self-regulated learning (Nicol & Macfarlane-Dick, 2006). This is particularly the case in vocabulary learning with reports showing that learners have a limited bank of strategies that they use First Language (L1)to learn Second Language (L2) vocabulary and that predominantly they rely on simple repetition to master thousands of words needed for language proficiency (Coxhead & Nation, 2001). One of the ways to tackle this issue is to teach students learning strategies that can be adopted to help the learner become more autonomous and self-regulated in their learning practice.

2.1.3 Vocabulary Learning Strategies

Vocabulary learning strategies play an important role in vocabulary learning (Cohen, 2014; P. Y. Gu, 2002, 2018). Oxford (1990b) divided vocabulary (language) learning strategies to direct and indirect strategies. The direct strategies focus on the mental processing of the target vocabulary learning and is divided into

a) memory-related strategies in which the learners link a L2 concept with another (e.g., using a mental picture and using a mechanical mean such as flashcards),
b) cognitive strategies in which the learners analyse the language material directly (e.g., using reasoning, note-taking, summarising, analysis, and so on),
c) compensation strategies in which the learners use the context for the missing knowledge (e.g., guessing from the linguistic clues) (R. L. Oxford, 1990b).

The indirect strategies as the name implies focus on facilitating indirect learning of the target vocabulary (without directly focusing on the mental processing of the target vocabulary learning) and is divided to

a) affective strategies in which the learners' mood and anxiety level is considered (e.g., rewarding the learner for performance),
b) metacognitive strategies in which the learners manage the learning process (e.g., setting goals and objectives),

c) social strategies in which the learners work with others (e.g., asking questions, cooperating with others, and empathising with other individuals) (R. L. Oxford, 1990b).

In Lawson and Hogben's (1996) study, the following categories were considered for grouping students' learning strategies

a) repetition
    i. reading from related words
    ii. simple rehearsal
    iii. writing word and meaning
    iv. cumulative rehearsal
    v. testing
b) word feature analysis
    i. spelling
    ii. word classification
    iii. suffix
c) simple elaboration
    i. sentence translation
    ii. simple use of context
    iii. appearance similarity
    iv. sound link
d) complex elaboration
    i. complex use of context
    ii. paraphrase
    iii. mnemonic (the KWM)

Schmitt categorised mnemonics and the inferencing strategies into

a) word part analysis,
b) context use for lexical inferencing,
c) incidental vocabulary learning from reading, and
d) reference source utilisation (e.g., a dictionary) (Schmitt, 1997).

Although FL vocabulary learning strategies have been addressed in many studies, few research studies have investigated these strategies in depth. Schmitt and McCarthy (1997) categorised vocabulary learning strategies to

a) guessing from context,
b) utilising word parts and mnemonics, and
c) using flash cards.

Other researchers classified vocabulary learning strategies similarly but used different terminology. For instance, Celce-Murcia (2001) grouped the vocabulary learning strategies to

a) learning from context,
b) learning through mnemonic devices (keyword technique), and
c) vocabulary notebooks (learning via setting up vocabulary notebooks).

In some research studies, the blurriness of various definitions of learning strategies are addressed while advising that the usage of a number of strategies concurrently does not necessarily help the learner to be a successful and confident strategy user (e.g., Tseng et al., 2006). Learners may not know the strategies for learning new word-pairs (Barcroft, 2009). As a result, learners mainly utilise simple repetition strategies for vocabulary learning (Nation, 2001), while not applying strategies that have been shown to be more effective for vocabulary retention (Macaro, 2006). As on most occasions the teachers do not teach the learning strategies (Chamot, 2004, 2005), the learners are left on their own to use the means they have. Hence, it is important to teach effective learning strategies such as the KWM to learners.

2.1.3.1 The KWM

The KWM is one of the most useful strategies for vocabulary acquisition (Beaton et al., 2005; Bell, 2008; Lawson & Hogben, 1998; Pressley, 1977; Pressley et al., 1980, 1981, 1982; Pressley & Dennis-Rounds, 1980a; Raugh & Atkinson, 1975; Wyra et al., 2007). The mnemonic KWM is usually defined as a two-step procedure (Atkinson, 1975). In the first step (association) to learn a new FL word and its meaning, the learner identifies and makes an association between the new target word and a familiar word (keyword) in that learner's L1. This familiar word is a word that has an orthographic or an acoustic similarity to the FL target word. The second step

(elaboration) relies on mental visual imagery. The learner needs to make a mental image of the keyword interacting with the L1 meaning of the target FL word. It is important to point out that the learner needs to be instructed to remember both the image and the association for FL target word retrieval (Mastropieri et al., 1986). This strategy has been found to be easily learned by students, enjoyable but most importantly effective for learning a large number of words and for long-term retention (e.g., Beaton et al., 1995; Lawson & Hogben, 1996; Wyra et al., 2007).

The KWM was the sole focus in Atkinson and Raugh's (1974) publication in which the authors indicated the KWM helped learners in acquiring vocabulary in the Russian language (Levin, 1993). As Russian vocabulary has a different phonological system to English, a learning challenge was introduced in this study (Reed, 2006). In Atkinson and Raugh's study, 120 Russian-English word-pairs were divided to 3*40 sub word-pairs. Each sub word-pair was to be learnt and tested on days one, two, and three by the two participant groups; one group receiving the KWM strategy training to utilise it and the other group using their own preferred strategy (Atkinson & Raugh, 1974). After the test occasions on days one, two, and three (total of three test occasions – one on each day), on the fourth day, a test (immediate recall) which included all 120 word-pairs was taken by learners. A similar comprehensive test (delayed recall) was repeated after approximately six weeks later. According to the reported results, an average of 46% and 72% of the provided word-pairs were recalled by the KWM group while the control group recalled only 28% and 43% of the words for the immediate and the delayed recall.

The next section focuses on the literature regarding the KWM underpinning learning theory.

2.1.3.1.1 Learning Theory

Some of the main reasons of mnemonic strategies' effectiveness are the organisation of the information in memory, how the underlying structures hold together the details, and the help with the information recall (Manis, 1966). Mnemonic strategies benefit from information association and elaboration (as defined in section 2.1.3.1) to provide an organised structure (Eysenck, 2001). The underpinning theory of the KWM is Paivio's (1971) dual-coding theory. Based on this theory, verbal and visual coding

systems are utilised as two distinct yet interconnected systems to store information in the mind (Paivio, 1971). A number of scholars considered image generation as an efficient strategy for encoding (e.g., Agramonte & Belfiore, 2002; Anderson, 2005; Cramer, 1981; Levin et al., 1973). Furthermore, the visual imagery usages in mnemonic strategies (e.g., as used in the KWM) improves both learning in various contexts (Eysenck, 2001) and the memory itself. This is because imagining the information to remember it (encoding strategy e.g., in the KWM) can improve memory capabilities (Magnussen & Helstrup, 2007).

2.1.3.1.2 Information Processing in Vocabulary Learning with the KWM

2.1.3.1.2.1 Association, Elaboration, and Imagery Link

As defined previously (section 2.1.3.1), association refers to associating the new target word with a familiar word (keyword) in that learner's L1. Elaboration refers to elaborating the information to remember a particular piece of information. The imagery link refers to producing the visual/acoustic imagery usages in the KWM. The following paragraph of this section discusses how association, elaboration, and imagery links are defined and used in the literature.

Atkinson and Raugh described the KWM as "a chain of two links connecting a foreign word to its English translation through the mediation of a keyword" (Atkinson & Raugh, 1974, p. 1). They further described the procedure of associating the new to-be-learned word through acoustic links (similarity in sound that links the FL word to a keyword), and imagery link (the mental image that links the keyword to the English translation). For instance, for an English native speaker to learn the Spanish word 'vaca', 'cow' could be introduced as a keyword and the learner could be instructed to imagine a cow cleaning a field with a vacuum cleaner (Gruneberg, 1987). In this case, the association between 'vaca' (the new word) and 'vacuum' (the keyword – the known word in L1) along with the imagery link contributes to the KWM effectiveness. Many scholars appraised having a visual image as an indicator of an efficient mnemonic technique (e.g., Beaton et al., 2005; Shapiro & Waters, 2005). Pondering the two steps for the KWM procedure, Pressley et al. (1980c) regarded the first process for association (asking the learners to associate the target word with a keyword with similar pronunciation of the target word) and the second for image development (asking the learners to develop a mental image in which the keyword and the meaning

of the target word are interacting). Similarly, Lawson and Hogben (1998) presented a two-stage elaborative procedure as Atkinson (1975)

a) generating the keyword based on target vocabulary and
b) development of the interactive image.

However, in Lawson and Hogben's (1998) description of the first stage, a keyword was chosen based on sounding and looking similar to part or all of the FL word while the second step was the same as Atkinson's (1975). Agreeing with Atkinson's approach, van Hell and Mahn (1997) also explained the steps similar to those of Lawson and Hogben (1998). They described the KWM as a strategy to link the keyword or word from the language to be taught phonologically and/or orthographically to resemble the target language word. All these scholars had the same procedures for the second step (elaboration) of the KWM. Likewise, Sagarra and Alba's (2006) definition of the KWM emphasised a complex cognitive process as opposed to shallow processing in rote memorisation of word-pairs. In this definition, learners needed to process through a multi-step procedure to learn vocabulary. In other words, the processes were the same as Atkinson's (1975) (linking the target word to a keyword and relating an image to relate the two words) with an addition of explanation for the cognitive complexity in the recall process. Therefore, after being presented the target word, learners needed to recall the keyword at first, leading to the image, and then the translation in the end. The process urged the learners to recall words both receptively and productively along with conceptualising the target word via the link between the keyword and its meaning.

For the current study, a range of studies that utilised the KWM were reviewed. Based on the languages, either orthographic or acoustic or both links were applicable. For example, acoustic links were used in the studies by Atkinson and Raugh (1974) and Pressley (1977a). Orthographic links were used in the study by Desrochers et al. (1991). A combination of acoustic and orthographic links were used in the studies by Wyra et al. (2007) and Mirzaei et al.(2018). In non-alphabetic languages only the acoustic aspect was used (e.g., Anonthanasap et al., 2015; Wyra, 2019). For the current study, although Persian is alphabetic, as the alphabet is different to English, only acoustic links were used (e.g., Atkinson & Raugh, 1974).

2.1.3.1.2.2 Overlap and Repetition

A combination of verbal and visual coding systems in dual-coding theory (discussed in 2.1.3.1.1) is possible; however, for any given item, more emphasis is normally placed on one or the other. For instance, it might be more efficient to code 'sensitivity' as an abstract word verbally while 'mouse' as a concrete word might be more efficient to be coded visually (Shapiro & Waters, 2005). Also, some studies showed that repetition (having several test occasions) can lead to better performance of the memory as it helps with strengthening the verbal and visual codes (Paivio & Desrochers, 1979).

In the next section, other strategies and the KWM are compared.

2.1.3.2 Other Strategies and the KWM

A number of vocabulary learning strategies are utilised for FL vocabulary learning. Gu (2003) categorised vocabulary learning strategies to the following types

a) task-dependent guessing,
b) dictionary,
c) note-taking,
d) rote rehearsal, and
e) encoding.

Table 1 presents FL vocabulary learning strategies, types and findings based on Gu's (2003) study.

Table 1. Vocabulary learning strategies (P. Y. Gu, 2003)

Strategy	Type	Findings
Dictionary	b) dictionary	Little empirical research finding about this strategy, how it is utilised by learners, and its effectiveness. Most studies compared dictionary definitions with contextual guessing while favouring the contextual guessing approach.
Note-taking	c) note-taking	This strategy is for learners who utilise vocabulary notebooks, vocabulary cards, or simply take notes along the margins or between the lines after receiving information about a new term. To find out how different forms of note-taking practises affect vocabulary acquisition, more research is needed.
Rote rehearsal	d) rote rehearsal	As the rote rehearsal strategy is the first and simplest strategy that learners utilise naturally, most early research studies were focused on it. Rehearsal can be ignored as a) most vocabulary rehearsal research studies were conducted before the 1970s, b) later studies have concentrated on deeper strategies (e.g., encoding strategies), and c) empirical research in this area has generated conclusive findings. Additionally, the number of required repetitions, low number of optimum words to learn at one time, and repetition timing are some of the issues in these strategies.
Encoding	e) encoding	Focusing on memory, these strategies have received most research studies' attention. The implicit assumptions underlying this strategy are

Strategy	Type	Findings
		a) mnemonic devices help with boosting memory, b) vocabulary learning is primarily a memory problem and, c) mnemonics should also work for FL vocabulary learning. Most empirical studies involve a type of mnemonic device (the KWM) with a similar conclusion that the KWM is superior to other strategies (e.g., other strategies in this Table).
Word-formation	a) task-dependent guessing	Focused on form, these strategies are based on utilising etymological information such as "1) etyma and cognates; 2) morphological analyses of lexical units in terms of constituent structure; 3) morphological analyses of lexical units in terms of word formation processes; and 4) analyses of lexical units in terms of cognitive procedures (e.g., metaphor) of their formation and development" (P. Y. Gu, 2003, p. 13). To employ these strategies, learners should be able to a) break the words into affixes and roots, b) obtain knowledge of the meaning of the broken parts and,

Strategy	Type	Findings
		c) connect the meaning of the broken parts to the word-to-be-learnt meaning.
Semantic networks	a) task-dependent guessing	Focused on meaning, in these strategies, words are shown in terms of interrelated lexical meaning maps or grids. Some empirical studies suggest the effectiveness of these strategies while others warned about use of closely related new words.
Contextual Learning	a) task-dependent guessing	Focused on language context, in these strategies, learning new words from context is utilised in different approaches as a naturally employed strategy. Some learners make use of this strategy with metacognitive choice of word to encode the word-to-be-learnt with the context it appears in (e.g., using the surrounding sentence to remember the word). Another approach is to produce a sentence with the word-to be-learnt and employing it in the context. Empirical studies on these strategies have primarily compared “incidental vocabulary learning from context with other forms of vocabulary presentation” (P. Y. Gu, 2003, p. 15).

Strategies presented in Table 1 can be employed in incidental and intentional learning. Ortega defined incidental learning as “learning without intention, while doing something else” (Ortega, 2014, p. 94) and S. Gu defined intentional learning as learning with “the deliberateness on the part of learners to attend to the stimulus” (2017, p. 27). For vocabulary recall, intentional learning is more efficient while recognition requires incidental learning (Eagle & Leiter, 1964). Some studies considered guessing from the context (or guessing in general) as incidental learning (e.g., Kelly, 1990) as the intention is comprehension rather than learning the words.

The following paragraphs will provide a brief comparison on the KWM and the context learning strategies as the most common and extensively researched direct and indirect vocabulary learning encoding strategies, respectively (e.g., Atkinson & Raugh, 1974; Hulstijn, 1992; McDaniel et al., 1987; Pressley et al., 1980b).

The context strategy is based on using the vocabulary in several sentences while the learner is capable of decoding the vocabulary meaning in these sample sentences (Greenwood, 2002). For instance, the instructor presents a short paragraph with the target vocabulary highlighted in it and some questions or hints to guide the learner towards spotting the correct meaning. These hints could be prefixes, suffixes, antonyms, synonyms, and so forth to lead the learners into the correct meaning (Nash & Snowling, 2006) to help them become independent learners as explicit instructions are not provided to the learners (Celce-Murcia & McIntosh, 1991). The context strategy, as an indirect strategy, employs the learner’s background knowledge and current expertise. According to Rodriguez and Sadoski (2000), the context method is a strategy in which learners infer the target word meaning based on its usage in a series of sentences “whose contexts strongly suggest its definition” (Rodriguez & Sadoski, 2000, p. 388). Rodriguez and Sadoski (2000) concluded that the context methods showed promising results for long-term retention.

Many studies considered the KWM as an effectiveness strategy for FL vocabulary learning (Atkinson & Raugh, 1974; Cohen, 1987; Desrochers et al., 1991; J. Hulstijn, 1996; Nation, 1982; Paivio & Desrochers, 1981; Pressley, 1977a; Wyra et al., 2007). In most of these empirical studies, a variation to the study design was employed (e.g., using acoustic, orthographic or both links). The experiments in these studies included the task(s) on the recall of a list of word-pairs, which included the FL target word, the

learners' L1 meaning, and a keyword. These experiments in all these studies were conducted within different time frames (e.g., two four-week periods) to test either immediate or delayed recall or both. The findings in all these studies suggested that the KWM participants had higher recall compared to other tested strategies (e.g., context strategy, rote learning, placing words in sentences, or semantics).

2.1.3.3 The KWM Effectiveness

Based on the review of literature from different scholars, the KWM is found to increase vocabulary acquisition and retention (Atkinson, 1975; Beaton et al., 2005; Campos et al., 2004; Lawson & Hogben, 1998; Pressley, 1977; Pressley et al., 1980, 1981, 1982; Pressley & Dennis-Rounds, 1980a; Raugh & Atkinson, 1975; Sagarra & Alba, 2006; Wyra et al., 2007). Atkinson's (1975) indication of recall of a greater number of words at a faster rate compared with other rote memorisation strategies was supported by scholars such as Campos et al. (2004) and Sagarra and Alba's (2006) findings. Gu's (2003) study compared the strategies listed in Table 1 (2.1.3.2) outlining that "two and a half decades of rigorous experimentation points to a single conclusion that the keyword method is superior to almost all other methods tested (e.g., rote repetition, semantic methods, or placing words in a sentence)" (p. 12). Some of the aspects found in the research studies discussed in this section were retrieval time (the time between instruction and testing), learners' age range (elementary to college students), learners' proficiency level (novice to advanced), learners' L1 (effective in a number of languages), and study design variations.

2.1.3.3.1 Retrieval Time

When compared to the rote learning strategy, the KWM is more effective for delayed recall (Carney & Levin, 1998; Fritz et al., 2007). In Carney and Levin's (1998) study, this delayed recall was five days after the initial instruction while in Fritz et al.'s (2007) study, this recall was tested a week after the initial test. In van Hell and Mahn's (1997) study, they tested vocabulary recall in a one-week and a two-week interval while Beaton et al. (2005) stated that the KWM delayed recall success can extend even more than 10 years.

2.1.3.3.2 Learners' Age

Being conducted in different research studies with participants with different age ranges, the KWM benefited all learners of different age groups. Pressley et al.'s (1980c) experiment included college-age students while Pressley et al. (1980) and Campos et al. (2004) had elementary and middle school students in their experiments, respectively. All these studies indicated the KWM as a successful FL vocabulary acquisition strategy.

In the current study, age range was restricted to learners aged over 18 years and students from universities and language learning institutions were targeted.

2.1.3.3.3 Learners' Proficiency Level

The KWM has been implemented in different research studies, which included learners with different language proficiency levels. In van Hell and Mahn's (1997) study, they had both novice and experienced FL learners whereas Sagarra and Alba (2006), and Hogben and Lawson (1994) included novice or elementary FL learners in their studies. In all these studies, scholars have indicated that the use of the KWM benefited the learners over the conventional rote learning strategy.

2.1.3.3.4 Learners' L1

In van Hell and Mahn's (1997), the KWM's capabilities in increasing immediate recall in adults and children in numerous languages including Russian, German, Tagalog, and Chinese were discussed. They also concluded that the KWM is effective regardless of how the keyword was allocated (either provided by the researcher or produced by the learner) (van Hell & Mahn, 1997). The scope of the KWM was also discussed in their research study, which covered a wider context than FL learning, for instance, for learning botanical concepts, names, and so forth (van Hell & Mahn, 1997).

2.1.3.3.5 Study Design Variations

Different scholars who investigated the KWM have stated that variations of the study designs have had successful results like the original one. For instance, Hogben and Lawson (1994) applied a multiple elaboration strategy (i.e., use of additional strategies

for making word links such as use of grammar comprehension to make word links) to the original KWM training and reported significant gains for overall recall and not apparent effects for delayed recall of two week. Furthermore, in Pressley et al.'s (1980c) and Pressley et al.'s (1980) studies, the self-generated sentence of the KWM which required learners to generate their own sentence to connect the foreign word to the keyword was used. Pressley et al. (1980c), Pressley et al. (1980), and Campos et al. (2004) also used subject-generated-keywords and compared it to experimenter-generated keywords. According to Pressley et al. (1980c), Pressley et al. (1980), and Campos et al. (2004), the difference between the two variations are not considerable.

2.1.4 Memory and Vocabulary Learning Processes

According to the Merriam-Webster (2020) dictionary, memory is the power or process of reproducing or recalling what has been learned or experienced previously.

Atkinson and Shiffrin (1968) considered three main phases for information processing including retrieval

1. Encoding or registration: in this phase, the information is received, processed, and combined.
2. Information storage: in this phase, a permanent record of the encoded information is created.
3. Retrieval, recall, or recollection: in this phase, the stored information is retained to be used in a process or activity.

The main goal of vocabulary learning instruction (for instance, in the KWM) should be based on how it influences the vocabulary long-term memory storage (Paas & Sweller, 2014; Sweller, 2005). One of the key elements influencing the long-term memory is how the information is encoded and how the encoding can influence the availability of the information at the time of recall/retrieval (e.g., Atkinson & Shiffrin, 1968).

2.1.4.1 Retention

In the present research study's design phase, it was important to understand and consider the underlying cognitive mechanisms for information retrieval and retention. Many aspects were investigated to assess the functionality of a learning strategy. In the KWM, it is crucial to review the cognitive resources and KWM strategy usage by the learners. Salonen et al. (2005) categorised the processes required for learning in

memory into cognitive, meta-cognitive, affective, motivational, interpersonal, and social control while separating the meta-cognitive processes in memory with the processes required for storing information for long-term retention. Based on the Salonen et al.'s study (2005), meta cognitive processes such as in vocabulary learning via the KWM requires knowledge of a task, strategy variables, and their interactions.

According to Atkinson and Shiffrin (1968), short-term memory receives its input from sensory registers (e.g., eyes) with a short-term life span (e.g., one or two seconds). After being attended (if not, received input is decayed), the received input is stored in the short-term memory with the capacity of six or seven items (G. A. Miller, 1956). After being rehearsed, the information can transfer to long-term memory (G. A. Miller, 1956). Eysenck (2001) called this process of information transfer from short-term to long-term memory 'encoding'. Baddeley and Hitch (1974) used Atkinson and Shiffrin's (1968) 'short-term' memory referring to 'working memory' defining it as the memory to hold, process, and manipulate information while considering it as the place for encoding the input information with previously stored information of long-term memory. Baddeley et al. (1998) discussed language learning at younger ages pointing out the 'phonological loop' and 'visuo-spatial sketchpad' terms to review verbal and visual/spatial information processing, respectively. Based on the working memory model by Baddeley and Hitch (1974), the central executive component is where the sources of information (e.g., verbal and visual or spatial information) are combined as presented in Figure 1 below.

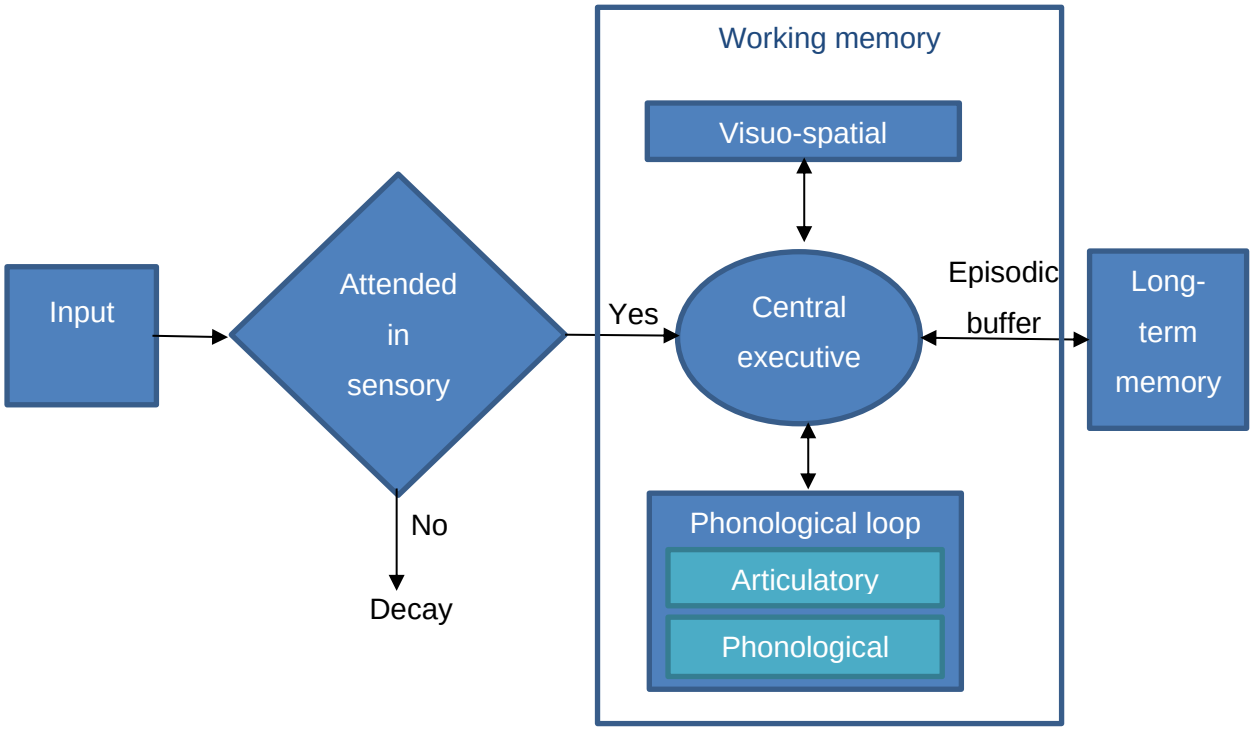


Figure 1. The working memory model components (adapted from Baddeley & Hitch (1974))

In the current research study, the terms 'short-term memory' and 'working memory' are used interchangeably referring to the working memory presented in Figure 1.

As presented in Figure 1, the central executive manages (organises) the system as a whole and deals with cognitive tasks (e.g., mental arithmetic) and data allocation to the subsystems (i.e., visuo-spatial sketchpad or the phonological loop); the visuo-spatial sketchpad subsystem which is the inner eye for navigating and visual and spatial data storing and processing; the phonological loop subsystem which includes the phonological (inner ear) and articulatory (inner voice) stores for speech perception processing with storing capability of one to two seconds and speech production processing to store the received phonological store's verbal information, respectively (Baddeley & Hitch, 1974). These temporary store systems (visuo-spatial sketchpad, phonological, and articulatory stores) are used to keep information in working memory whilst needed. The episodic buffer is used for the interaction between the working memory and long-term memory.

As stated by Baddeley and Hitch (1974) in this model (Figure 1), an encoding technique can help with both maximising the information storage and facilitation of long-term memory along with newly stored information (e.g., to-be-learnt information)

in combination. As defined by Anderson (2005), a mnemonic strategy (i.e., the KWM) is a technique to help with information encoding and retrieval to pair the information to be learnt with the already stored in long-term memory information. More specifically, the mnemonic strategies make use of the working memory components and their actions. There are a number of mnemonic techniques such as reduction (reducing the amount of information), elaboration (elaborating the information to remember a particular piece of information), loci (a technique to remember a large amount information in the correct order by using a mental route through familiar chunks of information), and the KWM (as discussed thoroughly in section 2.1.3.1).

2.1.5 Strategy Instruction

As reported by Hattie et al. (1996), strategy instruction can be effective when it is employed based on learners' capacity with proper training on the strategy utilisation. In other words, suitable training on utilising the encoding strategy is required and just providing the information to be learnt is not sufficient. Pressley (1990) recommended considering the strategy instruction training at the time of material design. Kirschner et al. (2006) indicated that use of worksheets and provided examples is useful for novice learners to a great extent since such learners require extensive guidance. In the current study, the strategy instruction training phases was regarded at the experimental design phase.

Some of the important factors to be reviewed in strategy instruction in educational settings are self-regulation, explicit instruction, and cognitive load (Seufert, 2018) since

a) it is important to raise strategy instruction awareness and successful use of strategies in FL vocabulary learning; FL learners should be taught self-regulatory techniques directly or indirectly (Ping et al., 2015),
b) explicit strategy instruction has been supported by a substantial body of literature in for educational success in vocabulary learning (Chamot, 2005), and
c) most of strategy instruction principles aim to reduce cognitive load by optimising the instruction (Seufert, 2018).

In the following subsections explicit instruction and cognitive load factors are discussed. Self-regulation was already discussed previously (section 2.1.2).

2.1.5.1 Explicit Instruction

Brown (2000) categorised explicit and implicit learning processes as key concepts of FL learning, which distinguishes learning from acquisition as these concepts are dealing with learners' (conscious) awareness of language. According to Brown (2000), explicit learning is consciously expressible knowledge that should be recalled before use while implicit learning is regarded as "acquisition of linguistic patterns without explicit attention or instruction" (p. 66) or autonomous behaviour that cannot be recalled (Berko, 1958). Ellis (2011) compared FL learners' implicitly acquired knowledge from communicative context with native speakers' acquired knowledge through learning processes and discussed limitations of implicit learning process such as FL learners' need for explicit learning and additional resources. DeKeyser (2000) debated that it is possible to utilise "explicit learning mechanisms to bypass the increasingly inefficient implicit mechanisms" (p. 518). Furthermore, some scholars discussed that providing learners with explicit instruction is essential as FL learning processes are different from L1 learning ones (e.g., Asher, 1969; Laufer, 2003; Munoz, 2008; Singleton, 1995).

Considering the undeniable value of vocabulary learning strategies for vocabulary acquisition success (e.g., Lawson & Hogben, 1996; Oxford & Burry-Stock, 1995; Pavičić Takač, 2008; Rubin, 1975), it is still of major concern that students often have a very limited strategy bank (e.g., Cohen, 2014; Lawson & Hogben, 1996) and that they do not use strategies effectively (Cohen, 2014; Green & Oxford, 1995). It is also of concern that self-regulated learning practices are not reflected in typical classroom practices which does not focus on explicit teaching of vocabulary learning strategies (Schmitt & Schmitt, 2020; C. B. Zimmerman, 1996). However, there is also little evidence that teachers explicitly teach students learning strategies and that students develop effective learning strategies during their schooling (Askell-Williams et al., 2011). This is also the case in the field of FL education, despite the evidence from over decades of research showing strong links between strategy use and FL learning success. However, explicit instruction in the use of strategies that can facilitate the acquisition of new vocabulary in a FL classroom is recommended (Coady & Huckin, 1997; Nation, 2001; Schmitt & Schmitt, 2020). Typically, with limited face-to-face teaching occasions in formal language teaching contexts, teachers indicate that there is no time to allocate for explicit language strategy instruction; instead, they favour the

focus on language acquisition and use (Coady & Huckin, 1997; Nation, 2001; Schmitt & Schmitt, 2020). One of the major issues with pedagogical approaches that depend on providing comprehensible input without explicit instruction is the lack of productive skills of FL learners in language learning. An example of such a problem was discussed in Clipperton's (1994) study in French Canada, where FL learners demonstrated acceptable reading and listening abilities while it was not the same for writing and speaking skills. Hunt and Beglar (1998) grouped vocabulary instruction approaches into

a) incidental learning,
b) independent strategy development, and
c) explicit instruction.

As stated by Hunt and Beglar (1998), in vocabulary learning explicit instruction, the instructor should choose the word to be taught to encourage intentional learning before elaborating word knowledge. Hunt and Beglar (1998) also advised that the students should be assisted with the development of fluency with already learned vocabulary. Nation (2002) stipulated that this approach can "add directly to both implicit knowledge and explicit knowledge" and is capable of "[raising] learners'…awareness of particular items, so they are more readily noticed when they occur in meaning-focused input" (Nation, p. 262).

2.1.6 Cognitive Load

Developed by Sweller, cognitive load theory (CLT) deals with mental efforts required in working memory at the time of learning (Sweller, 1988).

Sweller et al. (1990) classified cognitive loads as

1. intrinsic cognitive load (ICL),
2. extraneous cognitive load (ECL), and
3. germane cognitive load (GCL).

According to Sweller et al. (1990), ICL is defined by the learning tasks in which the learning material is fixed and not changeable. Low ICL tasks are the ones with non-interacting learning units. For instance, vocabulary learning is considered a low ICL task because of not needing to reference other units (Sweller et al., 1990). Low ICL

tasks can be learned serially as they have a low intrinsic load by not holding other unnecessary elements in the working memory while high ICL tasks such as grammar learning (where one single element is representing the schema) are processed the exact opposite way because of their high intrinsic load as learning units have a high level of interaction and tasks should be processed at the same time (Sweller et al., 1990; van Merriënboer & Sweller, 2005).

ECL is embedded in the material presentation and is based on instructional design (Sweller et al., 1990; van Merriënboer & Sweller, 2005). Instructions have several information sources mostly in forms of combinations of texts and diagrams; thus, mental blending is required, and this blending encourages high ECL, which might exceed working memory (Sweller et al., 1990; van Merriënboer & Sweller, 2005).

GCL is the schemata construction, which includes some instructional procedures. For example, tasks such as ‘questions asked in an exercise’ or ‘encouraging learner to learn via increasing GCL by asking them to complete an exercise’ could be considered for GCL (Sweller et al., 1990; van Merriënboer & Sweller, 2005).

Sweller et al. (1990) summarised human cognitive architectures as

1. the limited working memory capable of holding about seven elements of information at the same time while dealing with all conscious activities, processing, organising, comparing, and constructing information (only two or three items simultaneously). Comparing working memory to consciousness, Sweller et al. (1990) outlined that all cognitive functions should be brought into working memory before they are made available while Baddeley considered a “visual spatial scratch pad” and a “phonological loop” (Baddeley, 1992, p. 2) as two divisions of working memory,
2. the unlimited long-term memory to store schemata with various degrees of automatism.

Chi et al. (1981) defined schema as elements of information classified based on their usage. Thus, a schema could be used for organising and storing knowledge to reduce the load of working memory since elements to be processed in working memory are limited while size and complexity are not. Construction of schema occurs in working memory; however, with extensive practicing and occurrence of schema construction

automation, it is possible to bypass working memory to allow better performance on both familiar and unfamiliar aspects of tasks by freeing working memory capacity (Chi et al., 1981).

In designing the learning environments for the current study, all cognitive load types were considered so that the progress of learning could be maximised using the full capacity of working memory. As ICL is pre-established, optimisation of ECL (ECL reduction) could help with maximising the resources for GCL (increase in GCL) (Sweller et al., 1990; van Merriënboer & Sweller, 2005).

2.1.6.1 Multimedia Learning

Based on Mayer and Moreno's (2003) study, ECL can be reduced via altering how the learning materials are presented. According to Mayer and Moreno, ECL can be decreased with multimedia learning because different systems in the human mind can handle both pictorial and verbal material (Mayer & Moreno, 2003). Mayer and Moreno (2003) called this feature of the human brain the 'dual channel assumption' (DCA) and illustrated the cognitive theory of multimedia learning as shown in Figure 2 (Mayer & Moreno, 2003).

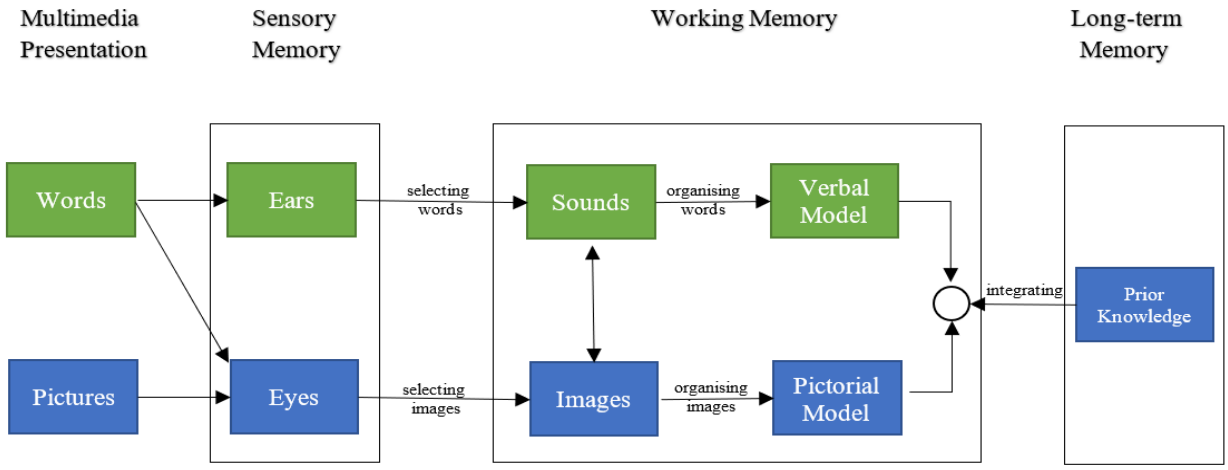


Figure 2. Cognitive theory of multimedia learning (adapted from Mayer & Moreno (2003, p. 44))

As presented in Figure 2, there are two different memory systems to store and manage the words. The processing of textual information are more easily understood with the help of pictures (Treisman et al., 1973). Mayer and Moreno (2003) discussed the principles presented in Table 2 for processing multimedia information in multimedia learning because careful considerations are required in this process, for example, the

same sensory memory (the eyes) is utilised for bringing the learning material (e.g., words in the form of texts) into the working memory while a combination of written text and pictures requires more mental resources than narrated text with pictures (Mayer, 2005; Mayer & Moreno, 2003)

Table 2. Principles of multimedia learning (Mayer, 2005; Mayer & Moreno, 2003)

Principles	Considerations
Contiguity	Concurrent (or near in time) and space presentation of textual and vocal information with corresponding pictures. If considerations are not met, the increase of ECL results in decreased performance in learning (Chandler and Sweller introduced the term 'split attention effect' for this) (Chandler & Sweller, 1992).
Coherence	Proper organisation of the learning material so learners follow the thread simply. According to Mayer (2005), the human brain tries to tie new information to the already stored information based on the context. If considerations are not met, this results in the increase of ECL (Mayer, 2005).
Redundancy	Only providing the essential information to increase efficacy. Mayer (2005) discussed how decoration and background music can contradict the learning outcome target while possibly being a pleasant learning experience (Mayer, 2005). If considerations are not met, learners are distracted by the redundant information (Mayer, 2005).
Individual learning	Learning material should be based on the level of learners. Kalyuga et al. (2003) defined their 'expertise reversal effect' as effectiveness of learning strategies when a learner's level ratio to the learner's expertise is considered.

As shown in Table 2, four principles of contiguity, coherence, redundancy, and individual learning were taken into consideration as the principles of multimedia learning. These principles were based on cognitive theory of multimedia learning (Figure 2).

The concepts of cognitive theory of multimedia learning (Figure 2) and multimedia learning principles (Table 2) were investigated and applied to the current research study to ensure that balanced cognitive load is utilised appropriately.

2.2 CALL/MALL

Computer/mobile-assisted language learning (CALL/MALL) refers to the application of computer technologies in language learning and teaching (Gamper & Knapp, 2002). CALL was introduced in the PLATO project in America in the 1960s for the first time (Marty, 1981). As an interdisciplinary field, CALL is formed with innovations in other fields such as instructional technology, technology-supported interaction, and psychology (Parmaxi et al., 2013). The term CALL refers to the use of technology in language learning while similar terms such as CALL, CELL (computer-enhanced language learning), CASLA (computer-assisted second language acquisition), TALL/TELL (technology-assisted/-enhanced language learning), and MALL are grouped in the same category. Stockwell (2012) outlined the subtle but distinct differences between these terms: CASLA and MALL as sub-terms under CALL, TELL as a broader-in-scope term than CALL.

In this study, the terms CALL and MALL are used interchangeably or together (i.e., 'CALL/MALL') referring to Mobile Learning (m-learning) to cover "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013, p. 4).

The definition of CALL has evolved over time. CALL definitions focus primarily on the concept of self-paced learning via computer devices. Clifford and Granoien (2008) considered learners' interaction, learners' input and output analysis, and providing feedback as features of CALL programs while Stockwell (2012) defined CALL as a language teaching and learning approach based on the technology and computer device usage to present, reinforce, and assess learning content to the learners.

Language learners and teachers view CALL a useful tool to obtain ideal language learning outcomes. Many research studies refer to the success in integrating CALL into traditional language learning occurring in classrooms (Almekhlafi, 2006; Grgurović et al., 2013; Hazaea & Alzubi, 2016; Lim & Zhong Shen, 2006; Son, 2018; Watkins & Wilkins, 2011; Wu et al., 2011). In modern society, learners and teachers have accepted CALL as an extensively sophisticated strategy for language acquisition (Chen Hsieh et al., 2016; Fan, 2011; Haryati, 2017; Morino et al., 2017).

CALL can be used in classroom or outside of class. Almekhlafi (2006) conducted an experiment with a total of 83 elementary-prep school EFL students in the UAE where the participants were divided into experimental and control groups to investigate the effects of CALL in the classroom. The results indicated students' preference to use ICT (information and communications technology) as a beneficial tool in their English class. In another study in a Taiwanese university, Chen Hsieh et al. (2016) investigated the effectiveness of flipped classroom model in an online written and oral environment to perceive the effects of interaction on the development of EFL learning and teaching in classroom. The results indicated that online flipped classrooms helped with students' learning motivation and improved their language knowledge. Based on research conducted by a number of scholars, CALL can also be an effective tool for improving students' language knowledge after the class has finished (e.g., Al-Jarf, 2004; Arifani et al., 2018; Lai & Gu, 2011; Liu, 2012).

While some researchers consider CALL as a less formal approach compared to the traditional in-class approaches (e.g., Alshammari et al., 2017; Hung et al., 2010; D. Zhang et al., 2004), an increasing number of teachers and students use it as a formal approach for after-class EFL learning and teaching around the world (González López, 2017; Huang & Hung, 2013; Hwang, 2018; Mazman & Usluel, 2010; Miyazoe & Anderson, 2010). In a research experiment conducted by Lai and Gu (2011) in Hong Kong, 279 EFL learners were surveyed and interviewed to investigate the use of online technologies in improving students' language learning outside classroom. The results suggested that various considerations should be made at the time of selecting a tool for after-class online language learning. Learners' behaviour was considered for external variables such as the length of study, accessibility of the tool along with internal variables such as digital literacy and efficiency of the tool. Lai and Gu (2011) reported that a number of learning and technological criteria must be considered to fulfil learners' requirement.

According to Warschauer and Liaw (2011), multimodal communication, collaborative writing, language analysis and structure, online networking, and one-to-one and mobile computing categories are the main criteria to be taken into account when employing CALL. Warschauer and Liaw (2011) defined multimodal communication as the incorporation of linguistic, visual, audio, gestural, and contextual elements. For

instance, use of tools such as podcasts, Skype, and generally peer-to-peer voice over internet protocol (VOIP) for learning purposes belongs to this category. According to Warschauer and Liaw (2011), collaborative writing is defined as an environment in which students can collaborate to produce blogs and wikis. For instance, use of a blog for a group assignment in a classroom belongs to this category. As reported by Warschauer and Liaw (2011), in language analysis and structure, learners can use tools such as text scaffolding, speech recognition, and online concordance for direct linguistic support. An example for this category could be a dictionary with the mentioned features. Warschauer and Liaw (2011) identified online networking as a multi-user virtual environment for learners' collaboration. For instance, any social media platform such as Facebook can be included in this category. Mobile devices and laptops can be included in this category as well.

Almost 1 in 2 people (48.2%) in the world own a mobile device (smartphone) (bankmycell.com, 2021). Mobile devices have many features such as

1. portability (can be used in different locations),
2. social interactivity (can be used to interact with others),
3. context sensitivity (can gather real or simulated data based on location),
4. connectivity (can be connected to other devices, or a network), and
5. individuality (can be customised to meet user needs) (Klopfer & Squire, 2007).

Two of the most important features of mobile devices used in learning are its portability and accessibility. A study by Cheng et al. (2010) outlined different features of mobile devices outlining that these features enable students to use their mobile devices to learn anytime, anywhere. In the designed system for their study, which was called 'ubiquitous computer supported collaborative learning', they incorporated a contextual application for EFL learning. In this system, multimedia maps of the campus were used on student phones for English learning. Students could record images, video, and audio to describe the environment around them. Students were also able to share the recordings with their peers. GPS location tracking helped students learn contextually relevant information about their nearby environment. It was also possible to post messages for writing practice purposes.

A study by Stockwell (2010) indicated the ratio of mobile device and PC usage for English language learning over three years. In this study, which was conducted at Waseda University, Tokyo, students were supposed to learn vocabulary outside of class via either their computers or mobile phones. The results of the study indicated that a majority (58.8%) of students did not use the mobile phones at all in 2007 while this rate rose to 78% in 2008 and dropped to 42.2% in 2009. However, with no difference in scores, students needed more time to do the activities on the mobile phones than on the computers. This could be the reason lower numbers of students used a mobile phone to perform the tasks. Another reason could be mobile interface or other mobile phone constraints (e.g., screen size limitations).

With the arrival of smartphones, mobile phone functionality improved to a great extent. Godwin-Jones (2011) explained how the initial web applications or Hyper Text Mark-up Language (HTML)-based programs led to the creation of the 'App Store' to allow third-party apps for iPhone to use most of the iPhone capabilities. Although the chosen platform for the current study is web-based, modern web-based platforms are mobile-responsive (W3C, 2021) and operate equally well on a computer or mobile device.

2.2.1 CALL and Vocabulary Learning

There has been an explosion of new technologies employed in FL education and a sustained growth of CALL/MALL field accordingly (Blake, 2013; Warschauer, 2004). Over the last decade, a gradual shift has been noted from the focus on new technologies as tools for content mastery (e.g., vocabulary glosses) and skill practice (e.g., four skills of reading, listening, writing, and speaking) to interest in pedagogy.

One of the e-learning areas that is proving to be useful in vocabulary learning is CALL/MALL. With ever-growing availability and increasing ease of access to mobile and web technologies, the opportunities and creativity of educational technology designers bring an abundance of choices. The interest underpinning the growth in CALL/MALL can be attributed to distinctive affordances of mobile devices: personal, informal, contextual, pervasive, ubiquitous, and portable (Kukulska-Hulme, 2009) with "language learning enabled by the mobility of the learner" (Palalas, 2011, pp. 76–77) and portability of handheld devices for anytime, anywhere access. This is particularly useful for learning of and with learning strategies and is of interest of the current study investigating the usability and applicability of a web application designed to teach the

KWM as a vocabulary learning strategy and to facilitate the use of that strategy for vocabulary learning and testing.

CALL/MALL is implemented in a vocabulary learning context in a variety of forms. Huang (2014) considered three categories for CALL/MALL; the first one is based on the idea of transferring information via computer devices; the second one is focused on pedagogical design, and the third one is based on context-aware technology usage. Puentedura (2010) used a substitution-augmentation-modification-redefinition (SAMR) model to discuss the role of technology in the learning process. Puentedura (2010) described SAMR as

1. substitution (technology alternates a traditional learning tool while having no functional change),
2. augmentation (technology alternates a traditional learning tool while having functional improvements),
3. modifications (technology helps in redesigning of the learning task), and
4. redefinition (technology helps with the creation of new learning tasks).

McFarlane et al. (2007) categorised activities in mobile design into the three discernible categories of

a) teacher-directed,
b) teacher-set, and
c) autonomous learning.

In the current research study, the autonomous and self-regulated learning was the target goal so that the learners could use the web application in the allocated time and in a self-paced (in future studies) fashion if required.

Situating the learners within their linguistic and cultural schemata, multimedia and computer devices can facilitate the learners with real-world experiences (Joseph & Uther, 2009). Viewing their study results as promising, Joseph and Uther (2009) considered the following recommendations as the key factors for acceptable CALL/MALL pedagogy implementation

1. considering learners' current ability and presenting learning material at their ability level, or just beyond it,
2. creating genuine task-based learning,
3. supporting interaction with others,
4. connecting with learners' current knowledge schemas,
5. showing visual and verbal information alongside each other,
6. learners should have the choice of modality,
7. learners should be prepared in advance. (Joseph & Uther, 2009, p. 16)

When compared with traditional pen and paper (P&P) learning approaches, CALL/MALL encourage flexibility and functionality in facilitating learning and teaching with the above pedagogical principles. What is more, the discussed features of computer devices such as portability, accessibility, constant user interactions, availability, and ease of use can further facilitate the learning and teaching processes within the discussed principles.

When designing the web application for this research study, the relevant CALL/MALL pedagogical implementation principles outlined in Joseph and Uther's (2009) study were reviewed to encourage flexibility and functionality to follow best practices in vocabulary learning and teaching.

CALL offers benefits such as working independently and in one own's time and pace for FL learners' vocabulary practice over traditional P&P (non-technological/non-computer based) activities (Hirschel & Fritz, 2013). Some studies have indicated significant vocabulary knowledge gains through the use of CALL tools (e.g., Horst et al., 2005; Kilickaya & Krajka, 2010). Lu's (2008) study findings suggested ubiquity, fun, effective time management, a manageable amount of content, and being helpful for studying as benefits of CALL for vocabulary learning.

The number of language learning platforms for vocabulary learning has increased significantly after the rise of mobile devices as learning can occur any time and in any place. For the current research study, it was important to investigate what language learning platforms are already available and identify the ones that support vocabulary learning. Some of the language learning platforms including Anki, Babbel, Busuu, Drops, Duolingo, Linkword, Memrise, Mindsnacks, Mondly, MosaLingua, Pictoword,

Pimsleur, Quizlet, Rosettta Stone, Supermemo, TripLingo, VoLT, Word Link, Word Ranch, Word With Friends, and Words were considered. Table 3 shows the list of the reviewed language applications and the platforms these language applications operate on, along with the availability of vocabulary learning and teaching features.

Table 3. Language learning platforms (PC: Personal Computer, iOS: iPhone Operating System)

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
4 Pics 1 Word	4 Pics 1 Word is a game based on an English dialect perspective. Its gameplay is designed simply: each level displays four pictures linked by one word while the player's aim is to work out what the word is, from a set of letters given below the pictures.	Android/ (iOS)	Yes	No	No
Anki	Anki is based on the flashcard concept to encourage retention of learnt materials. The primary concepts of Anki are spaced repetition (first published in 1972 (Craik & Lockhart, 1972), a learning strategy that includes repetition of learnt material within set time intervals) and active recall testing (a technique to remember the linked answers to asked questions).	Android/iOS/ Personal Computer (PC)/web	Yes	Partial	No
Babbel	Babbel offers vocabulary learning in 14 languages, for which it is possible to listen and repeat words and test what is learnt. Each class starts with step-by-step vocabulary teaching with pictures. Then, the taught words are utilised in related phrases and short dialogues based on a student's level to build conversation skills. After finishing each lesson, it is possible to view the vocabulary lists and choose from flashcards or writing exercises to review. The	Android/iOS	Yes	Partial	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
	focus on learning in Babbel is on real-life situations presented by interactive training lessons using multimedia.				
Busuu	Busuu offers 12 languages and covers individual word learning to simple dialogue and questions about the dialogue supporting audio and native pronunciation. The topic-based lessons teach skills and expressions connected to tasks. By being a contributor or a learner, users can collect points. Busuu also offers offline access, grammar tips, corrections by native speakers, and official certificates.	Android/iOS	Yes	No	No
Clozemaster	Clozemaster has an old-school look and feel and offers over 100 languages. It also provides an optional text-to-speech feature. Clozemaster is good in follow-up for testing what is recently learned or brushing up on a language learned years ago.	Android/iOS	Yes	No	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
Drops	Drops utilises word games with mnemonic associations. It offers 31 languages and has a companion app called ‘Scripts’ for learning to write character-based languages or languages with a different writing system.	Android/iOS/ web	Yes	No	No
Duolingo	Duolingo is one of the pioneers to base the app on the concept of merging gamification and language learning. It is designed for self-paced study. Users usually start with simple phrases and continue to complex sentences gradually.	Android/iOS	Yes	No	No
Linkword	Linkword was promoted by Michael Gruneberg at the early 1980s for the purpose of learning languages based on the similarity of the sounds of words. It is a mnemonic system that involves creating an easily visualised image to link the words together.	Android/iOS/ PC	Yes	Yes	Partial
Lirica	Lirica is a mobile app to learn languages with music.	Android/iOS	No	No	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
Memrise	Memrise facilitates vocabulary learning based on the concepts of merging memes and gamification. It utilises a learning strategy based on creating funny or bizarre associations with the learnt words. Courses are often designed with memes in mind to help remember the vocabulary. These memes are created by the users' community to earn points to advance in the Memrise hierarchy of users. Memrise uses spaced repetition and mnemonics. The spaced repetition algorithm focuses on when and how users should review each word and the app sends reminders to users accordingly. The memes addition takes care of the mnemonics part of learning.	Android/iOS	Yes	Partial	No
Mindsnacks	Mindsnacks is based on the concept of embedding gamification in language learning tasks. It offers seven languages and includes vocabulary, grammar, and listening skills. Users can start with short simple lessons covering basic concepts to be tested in the games before achieving the status of 'mastered'. Mindsnacks monitors a user's progress to show how much learning has occurred in every skill. The games are timed to keep the users engaged and the user is treated as a language explorer.	iOS	Yes	No	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
Mondly	Mondly is a language learning platform that includes 33 languages and supports gamified lessons in virtual reality (VR) and augmented reality (AR).	OS, Android, Oculus Rift, web	Yes	No	No
MosaLingua	MosaLingua is a mobile app based on the spaced repetition concept to help language learners efficiently learn words and phrases. Users have the option to start with a standard lesson with simple phrases and numerals or go for specific topical packs. Learning is measured with a self-assessed flashcard system to drill users on the words in a number of ways such as asking users to record, speak out, and spelling.	Android/iOS/ web	Yes	No	No
Pictoword	Pictoword is a language learning platform based on the concept of using the pictures to get two words and putting them together to make a whole new word. The puzzles are a combination of the pictures (for instance, a picture of an ear and ring will form ‘earring’), a homonym (for instance, a picture of a knight and mare will form ‘nightmare’) or what the pictures sound like (for instance, a picture of a taxi and dough will form ‘tuxedo’).	Android/iOS	Yes	No	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
Pimsleur	Pimsleur is an audio-based language platform that shows phrases in the target language first, then in users' native language to translate it into that language. Pimsleur was firstly developed on research conducted by linguist Paul Pimsleur.	Android/iOS/ web	Yes	No	No
Quizlet	Quizlet trains learners via flashcards and various games and tests their knowledge in an interactive vocabulary learning scenario. Users have the option to interrupt at any time to continue later. It is possible to customise the individual learning settings.	Android/iOS/ web	Yes	No	No
Rosetta Stone	Rosetta Stone is a subscription-based language learning tool that offers 24 languages and uses immersive learning (figuring out the meaning of words and phrases in context). The lessons are broken down to manageable packs and different topics are covered. It is possible to review users' progress with correct answers in pronunciation, vocabulary, and grammar.	Android/iOS/ PC/web	Yes	No	No
Supermemo	Supermemo is a language learning platform developed based on research into long-term memory and is a practical application of the spaced repetition learning strategy (Spitzer, 1939) by a number of psychologists.	Android/iOS/ PC/web	Yes	Partial	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
TripLingo	TripLingo is a language learning platform designed for international travellers to learn essential phrases, instantly translate voice, or connect to a live translator, and so forth. It offers an inbuilt voice translator, which renders the user's English in the FL and allows a call to a real translator when required.	Android/iOS	No	No	No
VoLT	VoLT focuses on a number of techniques for learning and recalling difficult English vocabulary. These techniques utilise visual aids such as pictures, memory keys, sentence usage, antonyms, and synonyms.	Android/web	Yes	Partial	No
WizIQ	WizIQ is a cloud-based virtual classroom and learning management system (LMS) for self-paced online courses. It supports Moodle and includes virtual classes, online tests, and educational content.	Web	Yes	No	No
Word Link	Word Link is based on the concept of linking words in a game-based environment. In other words, the users can test their vocabulary skills along with puzzle solving skills. In Word Link, words are built by swiping the letter blocks. The letters are stacked on one another. The user should use the first letter on the top of the stack to use the second letter. If the user is not able to solve a puzzle, there is a lightbulb button to generate a hint.	Android/iOS/ PC	Yes	No	No

App name	Description	Platform	Vocab Support	KWM	KWM Explicit Instruction
Word Ranch	Word Ranch is a word puzzle game with a scenario/story in a graphical environment. Users should look for the words of different lengths with present letters. The words can be two or more letters long and it is possible to swipe the letters on any direction to form a word.	Android/iOS	Yes	No	No
Word With Friends	Words With Friends is a multiplayer vocabulary game. Players take turns building words crossword-puzzle like the classic board game Scrabble.	Android/iOS/ PC/web	Yes	No	No
Words	Words offers FL learning with a game-based approach. It utilises thematic blocks to learn the exact topics that are selected by the user.	Android/iOS	Yes	No	No

In Table 3, the KWM column shows if these platforms included the KWM as a vocabulary learning strategy. ‘Partial’ in the KWM column refers to platforms that utilised some strategies (e.g., mnemonics or similar strategies). ‘Partial’ in the KWM explicit instructions column refers to platforms that utilised some instruction (e.g., simple step by step guide to use the platform only and not the strategy).The listed platforms in Table 3 provide tutorials, exercises, videos, chat options, and other communication tasks in different languages but few are supporting Persian to English language learning. Most of these platforms are mainly based on a number of teaching and learning strategies and provide a variety of supporting tools. However, only Linkword uses the KWM and other ones including Memrise, Pictoword, VoLT, Supermemo, and MosaLingua recommend the use of associations and elaborations but do not address explicitly strategy instruction that can effectively support the use of association and elaboration to improve vocabulary retention. My investigation shows that none of these platforms including Linkword use the strategies (including the KWM) with proper (i.e., as discussed in section 2.1.5) explicit instructions. For this reason, it was decided to design a web application with proper explicit KWM strategy instruction principles (discussed section 2.1.5) in mind.

2.2.1.1 Gamification for Vocabulary Development

Deterding et al. (2011) defined gamification as “the use of game design elements in non-game contexts” (p. 11) and Sheldon (2020) defined it as activities that are applied through game mechanics in a non-game context. In the current research study, gamification was in line with the definition provided by Deterding et al. (2011) and Sheldon (2020).

Gamification has not been utilised in an educational context for long and this area of research is relatively new. However, research in gamification usage in education is following an upward trend. Hamari et al. (2014) discussed a literature review of gamification studies and concluded that gamification has been used in educational contexts frequently as there is a great interest for it. Hamari et al. (2014) also found that gamification can be beneficial in educational studies. After analysing a number of studies on gamification, Hamari et al. (2014) reported that although motivation was increased in a number of studies, the motivational increase was highly dependent on context. Furthermore, in the mentioned analysis of gamification research, all examined

studies reported positive effects from the use of gamification. Finally, Hamari et al. (2014) recommended that while gamification may be beneficial, more research should be conducted to determine what can lead to these benefits.

A game is “a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” (Salen et al., 2004, p. 83). Some of the characteristics of games are rules, boundaries, feedback, the game world interface, context sensitivity, goals, challenges, a game environment, and balance (Oxland, 2004). A mobile game is a game played on a mobile device. Jeong and Kim (2007) defined mobile games as games that are conducted through handheld devices with network functionality.

Kukulska-Hulme (2009) stated that game-based learning connects language vocabulary development to games because of the strong association between CALL/MALL and mobile gaming. Additionally, Smith (1999) stated that vocabulary usage and reading fluency can increase in a vocabulary-rich environment. Thus, mobile games can assist vocabulary building by involving the learner with an active role while playing the game.

The current study was the first to consider explicit instruction, the KWM, and the UX/UI web-based technologies practices. Therefore, gamification would add another level of complexity and analysis of that would make it difficult to attribute the success or failure of the system. Accordingly, gamification was merely used for distraction purposes (non-game contexts) as discussed in the next chapter (sections 3.5.2.2 and 3.5.2.6).

2.2.2 CALL Challenges

Computer devices can facilitate learning; however, there are some possible challenges for utilising them in an educational environment. Some scholars have investigated such implementation challenges like the small screen size of most computer devices (e.g., Maniar, 2007; Thornton & Houser, 2005). Most of such challenges are in the hardware category focusing on physical aspects of computer devices. Other scholars have reviewed software development challenges (Chen, 2019). One of the primary difficulties in software or application development is the process of mapping the current learning system to a computer-based application. Chen (2019) considered the cost of software development and CALL/MALL

implementation as a challenge. He further discussed learners' distraction at the time of computer device usage and advised to use computer devices in non-academic environments. However, other scholars have recommended the use of computer devices for academic purposes, more specifically, for vocabulary learning, which is the focus of the current study.

In Taki and Khazaei's (2011) study, words were presented in the form of vocabulary annotations in a computer-based environment. They suggested that computer (mobile) devices are useful for language learning and teaching as in their study the participants performed well with the pictorial and written annotations for both vocabulary learning and teaching. Portability, connectivity, context sensitivity, social interactivity, and personalisation are counted as beneficial features of computer devices in self-regulated learning and teaching (Taki & Khazaei, 2011).

For the present study, the primary focus was on applying previous successful pedagogical practices to avoid any learning/teaching barriers. According to Walters (2012), although there are some benefits to utilising computer devices in CALL/MALL, pedagogical practice implementation could be difficult and challenging. In Walters's (2012) study, one of the key challenges was outlined as the important roles of teachers in all phases of implementation including planning, design, embedding technology in modules, and so forth. Accordingly, as teachers are not necessarily familiar with technology, some usability issues may arise.

Another common challenge and one of the drawbacks of CALL, which hinders language learning, is distraction (Alemi et al., 2017; Başaran, 2013; Dashtestani, 2014; Herrera Mosquera, 2017; Shahlou & Izadpanah, 2016). It is important that distraction is regarded and measured properly to minimise its negative effects on students' learning in the CALL context (Bani-Hani et al., 2014; C. Richards, 2005). According to Langan et al. (2016), technology use at the classroom contradicts with pedagogical and teaching practices as it may cause distraction; however, Gallegos and Nakashima (2018) outlined that technology could be beneficial in learning if its use and pedagogy are combined in well-designed teaching/learning practice. Additionally, learners might encounter other challenges such as anxiety, information redundancy, and lack of familiarity/preparation in CALL-based learning. These factors can lead to learners' boredom and lack of interest, resulting in unproductive learning outcomes (Campbell

et al., 2008; M. Tseng, 2010; Yaghoubinejad et al., 2016). A research study conducted by Lu et al. (2013) indicated that some learners were not fully interested in using CALL for language learning. This study included a total of 347 university students indicating that inadequate preparation and misleading instruction demotivated learners use of CALL. In Zeynep and Akdag-Cimen's (2020) study, technology and Internet related problems is listed as the second most common challenge of flipped classroom in English language learning. Lu's (2008) study findings suggested trouble in using the device, insufficient content, technical problems, and difficulty to study as challenges of CALL implementation in vocabulary learning.

In the current study, to avoid encountering the discussed challenges, educational recommendations of language learning professionals and reliable computer science consultants in every step of the web application design and development was sought. Furthermore, the technology was explicitly evaluated using SUS and the software was designed with having best practices in mind.

2.2.3 CALL Effectiveness

CALL employment in language education can lead to an enhanced learning experience (Alshahrani, 2016; Shin & Son, 2007; Uehara & Martinez Noriega, 2016). Some scholars have indicated that distance learning allows embarrassed students to benefit from a low anxiety learning experience (e.g., Peterson, 2011; Venere & Watson, 2017; Yi & Majima, 1993). An online language learning environment also motivates EFL students who have interaction issues in face-to-face classes to participate actively in learning tasks (e.g., AbuSeileek, 2012; Chu, 2008; Eskandari & Soleimani, 2016; Freiermuth, 2002; Khoshsima & Sayadi, 2016). Based on the results of a research experiment conducted by Chu (2008) in Taiwan with 364 participants, a CALL-based online language learning experiment encouraged embarrassed learners to participate actively in interactive tasks. The reason for this was mainly reported as students' positive perception of CALL because of lower anxiety levels and more comfortable learning environment.

Not only does CALL allow learners to engage in learning activities at any time (increasing learning flexibility) (Rubio & Thoms, 2014), but it also provides learners with the opportunity to choose their preferred language learning environment (to achieve their personal leaning goals) (Cercone, 2008; Ducate & Lomicka, 2008;

Young, 1991). The freedom to select the learning environment and flexibility in learning time are considered as strong personal features in language learning in the CALL context (Dang, 2011; Lizzio et al., 2002; Wang et al., 2009).

One of the key factors in promoting EFL learning in a CALL autonomous learning environment is evaluation (Chapelle et al., 2015). Some scholars have discussed online technologies' application for self-evaluation within students' learning process (e.g., Anwar & Husniah, 2016; Chang, 2007; Han & Keskin, 2016; Liao, 2016). Self-evaluation along with CALL-based technologies allow students to decide on future learning activities, the approaches to deal with learning challenges, and overall learning of the target language (Allen et al., 2016). In an experiment conducted by Smith and Craig (2013), EFL students' self-evaluation was investigated among 180 participants indicating that EFL students' self-evaluation ability could be a key factor in a CALL setting to shift students' role to active learners from an initial passive information receiver status.

2.2.4 Learning Theories and CALL

Learning theories such as behaviourism, cognitivism, and constructivism have existed long before the invention of computers. Combining these theories with CALL is the foundation on which many CALL-based systems specify their specific learning scenarios (Wahl & Winiwarter, 2011). A useful CALL-based system in language learning requires consideration of a number of factors including

a) addressing the learners' requirements and
b) taking pedagogical considerations into account at the time of activity design (Amaral & Meurers, 2011).

The following sub sections discuss different relevant learning theories which were considered in the current study to employ best CALL practices.

2.2.4.1 Cognitivism

Cognitivism is based on observations of behaviour changes, which are indicators of thought processes in the learner's mind.

Table 4 presents the key concepts in cognitive theory (Mergel, 1998).

Table 4. Key concepts of cognitive theory (Mergel, 1998, p. 7)

Key Concepts	Definition (How it Works)
Schema	Schema is an existing cognitive knowledge structure that is compared to new information. It could be extended, combined, or changed to assist new information.
Three-Stage Information Processing Model	At first, the new information (input) enters a sensory register. • The sensory register receives the information from the senses with a one to four second life span. The received input by the sensory register either reaches the short-term memory (aka working memory) or disappears via decay or being replaced. Then, the input information is processed in short-term memory and transferred to long-term memory for storage and retrieval. • Short-term memory is a memory type that receives the input information that is important or interesting from the sensory register. This information has a life span of maximum twenty seconds (more, if rehearsed). Short-term memory has a capacity of 7±2 items (can be increased via chunking the items into meaningful pieces) (G. A. Miller, 1956). • Long-term memory is a memory type that stores the information of short-term memory for information storage, retrieval, and use over a long period of time. Long-term memory capacity is unlimited and short-term memory items can be forced to long-term memory via rote memorisation in learning processes. For successful information retention, deep levels of processing (e.g., linking old and new information) could be useful.

Key Concepts	Definition (How it Works)
Meaningful Effects	Learning and remembering meaningful information is less complicated (Cofer, 1971; Good & Brophy, 1990). However, if the information is relatively meaningless, linking it with prior schema could make it less challenging to retain (Good & Brophy, 1990; Wittrock et al., 1975).
Serial Position Effects	Remembering items from the start and final points of a list is less complicated than the ones in the middle if the items are not differing distinctively.
Practice Effects	Retention could be improved by rehearsal or practicing specifically in distributed practice where the items (material) are associated with different context (by the learner) rather than a single context provided in mass practice.
Transfer Effects	Previous learning influences new tasks or items (material) learning.
Interference Effects	This is the effect arising from the interference of previous learning with new items (material) learning.
Organization Effects	Remembering is less complicated when the input information is categorised by the learner (e.g., in the form a list e.g., grocery list).
Levels of Processing Effects	The level of processing refers to how deep the processing level is. Deeper levels of processing help with easier remembering. “Words may be processed at a low-level sensory analysis of their physical characteristics to high-level semantic analysis of their meaning” (Craik & Lockhart, 1972; Good & Brophy, 1990; Mergel, 1998, p. 7).
State Dependent Effects	It could be less challenging to recall and remember within the same context, in which the learning has occurred within, than a new context.

Key Concepts	Definition (How it Works)
Mnemonic Effects	Strategies utilised for organisation of relatively meaningless input information to meaningful context or images is called mnemonics strategies.
Schema Effects	When the input information is not fitting an individual's schema, it would be more challenging for the person to remember the information. What the individual remembers and how they conceive the information might also be influenced by their previous schema.
Advance Organisers	In Ausubel's learning theory model, advanced organisers are utilised to relate what the learner knows to the new contents to be learned to increase retention, e.g., using narrative, graphic organisers, or skimming (Ivie, 1998). Ausubel's advanced organisers help the learners by enabling them to logically make sense of the lesson (Ivie, 1998).

To summarise the concepts discussed in Table 4, in cognitivism both observable behaviour and mental processes are taken into consideration. In other words, a learner's reaction to stimuli along with their rational thinking and conclusions are considered.

2.2.4.2 Constructivism

In constructivism, the learners use their problem solving in ambiguous situations as they can construct their own viewpoint of the world based on their individual and/or social negotiation of meaning experiences and schema (Mergel, 1998). Mergel (1998) categorised the construction in this process into realistic and radical categories; the former as "(cognition is) the process by which learners eventually construct mental structures that correspond to or match external structures located in the environment" and the latter as "cognition serves to organise the learner's experiential world rather than to discover ontological reality" (Mergel, 1998, p. 8).

In constructivism, a learner's knowledge is considered as a construction that is built on their interaction and experimenting. In other words, learning occurs in a setting that allows individual questions and answers in a social environment and is facilitated for example by chats, team-based learning, or virtual classrooms (Buzzetto-More, 2007).

In the study design steps of the current research study, constructivism was considered in employing the theoretical frameworks (discussed in section 2.3) to design the experiments accordingly to meet the proper technology learning outcome in form of a web application.

2.2.4.3 Connectivism

Connectivism is based on the concept of using internet technologies to provide an environment for learners to learn and share information across the web. Internet technologies include browsers, mail system, wikis, online forums, social networks, and so on. A massive open online course (MOOC) is an example of connectivism that is open to anyone who would like to learn and share in the world wide web (Downes, 2010; Siemens, 2005).

In the current study, as the web application was utilised for strategy learning and vocabulary learning and testing, taking the discussed learning theories into account

helped in proper design of the different study phases (discussed in detail in section 3.1).

2.2.5 CALL Usage in Persian

CALL has received a great deal of attention from Persian FL learners in recent years. Vaezi (2008) counted

a) using the Internet appropriately,
b) meeting people from other cultures, and
c) future career development as the primary reasons of CALL-based FL vocabulary learning in Iran.

Some scholars have reported learners' positive attitudes towards CALL for FL vocabulary learning (Dashtestani, 2016) while reporting mobile devices as an effective tool (Alavinia & Qoitassi, 2013; Khabiri & Khatibi, 2013). In a study by Farivar and Rahimi (2015) on 60 Iranian EFL learners, CALL's positive effect on autonomy of the learner was reported and the efficiency of the technology-enhanced language learning environment was emphasised. Some studies focused on effectiveness of CALL for FL grammar learning (e.g., Pirasteh, 2014; Sadeghi & Dousti, 2013) while some concentrated on FL reading skills (e.g., Marzban, 2011). Few studies covered CALL for FL listening (e.g., Hashemian & Fadaei, 2013) and speaking (e.g., Rahimi & Tavakoli, 2015) while a considerable number of studies discussed FL vocabulary learning (e.g., Ebadi & Ghuchi, 2018; Namaziandost et al., 2021; Nejati et al., 2018; Sedaghatkar, 2017; Shams, 2013; Shokrpour et al., 2019). All these studies discussed CALL's positive impact for self-regulated learning and reported promising results for CALL. Dashtestani (2016) outlined that CALL-enhanced vocabulary learning in Iran lacks strategy instruction. The investigation to find a research study that teaches a strategy (e.g., the KWM) and utilises it for Persian learners' vocabulary learning in a CALL environment has not yielded any findings except for Mirzaei et al.'s (2020a, 2020b) study. Some of these studies discussed vocabulary learning in CALL with the use of pre-built platforms (e.g., messaging or social networking applications), which are not built for vocabulary learning purposes (e.g., WhatsApp or Telegram) and lacked the learning strategies and explicit instructions (e.g., Ghobadi & Taki, 2018; Hashemifardnia et al., 2018) while some utilised vocabulary learning specific platforms without any strategy instruction considerations (e.g., Namaziandost et al., 2021).

Unlike the current research study, few of these research studies covered English–Persian vocabulary learning via technology appropriately (e.g., applications or software) and none utilised a learning strategy (e.g., the KWM) along with explicit instruction.

The next section presents the theoretical framework for the current study.

2.3 Theoretical Framework

The current research study was an interdisciplinary project in EdTech. Therefore, two frameworks were considered to engage the concepts of education in computer science or information technology (IT) and implement a CALL-based web application. Sub sections 2.3.1 and 2.3.2 discuss these two frameworks.

2.3.1 Koole's FRAME

The Framework for the Rational Analysis of Mobile Education (FRAME) model (Koole, 2006, 2009; Koole & Ally, 2006) has been recognised as influential and is cited in many CALL-based pedagogical studies (e.g., Kearney et al., 2012; Miangah & Nezarat, 2012; Park, 2011; Stockwell, 2010). This model considered the technical characteristics of computer devices along with social and personal aspects of CALL/MALL (Koole, 2006, 2009; Koole & Ally, 2006). In this model, the technology implementation in learning adoption covers aspects of Device (D), Learner (L), and Social (S) as presented via circles of the Venn diagram in Figure 3. In FRAME model

a) (D) refers to physical and functional aspects of computer (mobile) devices (e.g., hardware capabilities and well-design software features),
b) (L) describes learners' usage of previous knowledge and cognitive abilities and how future skills are developed, and
c) (S) addresses communication, collaboration, and interaction. (Koole, 2006, 2009; Koole & Ally, 2006).

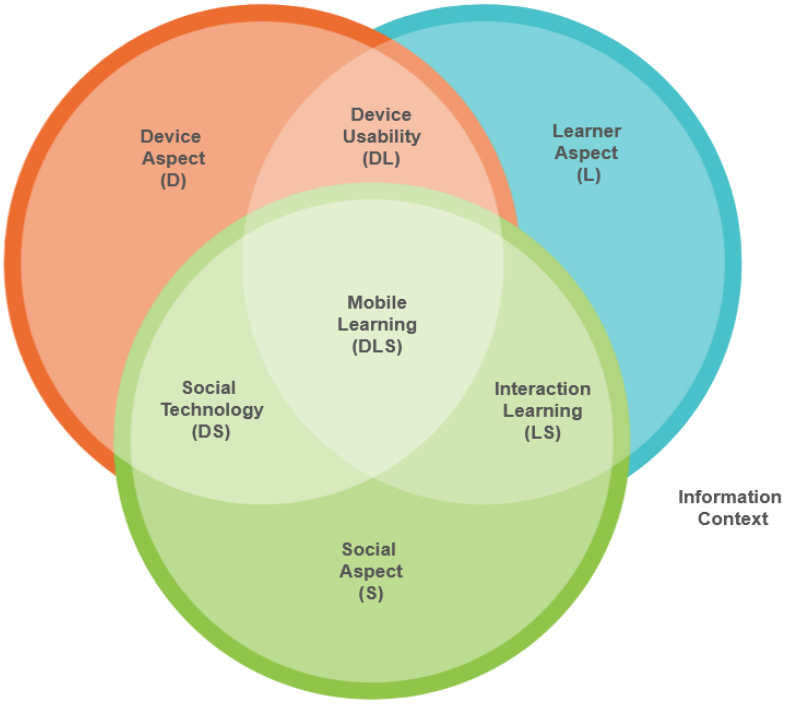


Figure 3. The FRAME model (Koole, 2009, p. 27)

The FRAME model (Koole, 2006, 2009; Koole & Ally, 2006) informed the current study in the following way

a) (DL) considerations resulted in the design of the web application for anywhere anytime information access,
b) (DS) considerations resulted in user collaboration design and connectivity (e.g., via the internet through the web application),
c) (LS) considerations resulted in the utilisation of culturally acceptable features (e.g., signs, symbols, and behaviours) in the web application, and
d) (DLS) is the key intersection in the centre of the diagram and the meeting point of the above aspects (DL, DS, LS) and would result in achieving the targeted learning tasks and platform design (web application) which encourages active participation of the learners.

As discussed in the literature (section 2.2.4.2), according to constructivism theory (Buzzetto-More, 2007), learners can construct new understandings and knowledge, and integrate this knowledge with what they already know. In the experimental study design of the current research, (L) aspect of the FRAME model was directly linked with the constructivism and cognitivism theories in relation to memory. Accordingly, two word-sets were used in the current study; only for the first word-set, the learners were

presented with the KWM strategy training to investigate whether they could utilise the strategy for the second word-set (constructivism theory).

2.3.2 Ma's Memory-Based Strategic Model

Ma's (Ma, 2014, 2017)'s memory-based model is cited in a number of studies for technology use in vocabulary learning and teaching (e.g., Gu, 2012; Kuru Gönen, 2019; Miller & Wu, 2018; Muhamad & Kiely, 2018). According to Baddeley et al. (2009), vocabulary learning as a cognitive activity utilises mental processing; after receipt of the information by the visual or sensory store, the new information is stored in short-term (working) memory (as discussed in section 2.1.6) and finally, ends up in the long-term memory (Ma, 2017). Therefore, a staged process is required for vocabulary learning (Ma, 2017).

Ma's (2014) memory-based strategic model is specifically designed for vocabulary learning purposes and was tested on large-scale questionnaire data of 300+ participants (Ma, 2017). As shown in Figure 4, this model presented two four-phase collateral processes for vocabulary learning with unobservable cognitive processes in the internal memory system phases (phases 1-4) corresponding to "conscious to the learner or observable by an outsider, or both" (Ma, 2017, p. 46) relevant external strategic behaviours and internal thoughts phases (phases 1-4) (Ma, 2017).

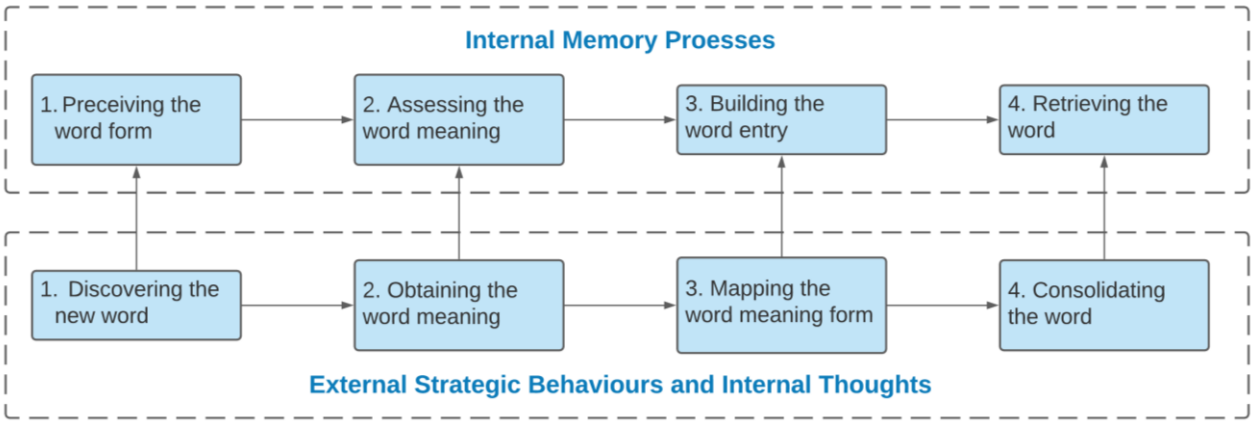


Figure 4. A memory-based strategic model for vocabulary learning (Ma, 2014, p. 43)

The four phases for the internal memory processes shown in Figure 4 are

1. Perceiving the word form.
2. Accessing the word meaning.
3. Building the word entry in the mind.

4. Retrieving the word from the mind.

These phases preside over the “corresponding strategy-driven processes: (a) discovering the new word; (b) obtaining the word meaning; (c) mapping the word meaning with form; (d) consolidating the use of words” of the external strategic behaviours and internal thoughts (Ma, 2014, p. 42). The two process types (internal memory processes and external strategic behaviours and internal thoughts) “are constantly in interaction with each other” (Ma, 2014, p. 42). The stimulus produced in learners’ brain by the learning task results in “internal thoughts (metacognition or cognition) about the strategy planning, execution and monitoring, prior to actually tackling the learning task” (Ma, 2014, p. 43). According to Ma (2014), the learners convert the strategies to solid actions based on the particular tactic they use (e.g., using the KWM for vocabulary learning). Ma further outlined the interaction of the processes “thoughts, strategies, and tactics” (Ma, 2014, p. 43) and the memory processes in which the new words are “decoded, encoded and stored in the memory” (Ma, 2014, p. 43).

Ma (2017) discussed the internal memory processes by reiterating the phases as the perception of the new word via visual or auditory inputs by a learner’s brain at the time of, for example, reading or listening as

a) phase (1): accessing the new word meaning via the mental lexicon for instance, via guessing/checking the dictionary,
b) phase (2): establishment of the new word as new FL entry in mental lexicon “by connecting the existing meaning (initially in L1 translation and later in FL meaning) with the new word form via repetition, imagery, or rhyme, and so on” (Ma, 2017, p. 47),
c) phase (3): retrieval of the learnt word from the lexicon for use in phase (4), and
d) phase (4): use of the retrieved learnt vocabulary in phase (3).

Ma (2017) recommended that language teaching professionals consider the four mental phases of this model at the time of vocabulary learning task design and emphasised the importance of explicit strategy instruction in technology-enhanced vocabulary learning domains. Additionally, along with introducing the memory-based strategic model for vocabulary learning, Ma (2017) introduced an updated version of

her framework for technology-mediated L2 lexical applications (Ma, 2013). In this framework (Ma, 2013), she discussed lexical applications and tools and how these applications primarily attend phases (3) and (4) of L2 (FL) vocabulary learning (Figure 4). Ma (2017) considered the following categories for lexical applications

1. technology-mediated incidental learning with textual, aural, or visual input (e.g., incidental learning from reading online sources and checking word meanings via e-dictionaries),
2. technology-mediated communication-based lexical learning (e.g., using social communication tools such as WhatsApp or Telegram to interact with learners for vocabulary (language) learning purposes),
3. e-vocabulary lists/flashcards/exercises (e.g., applications such as Anki and SuperMemo (Table 3) in which the learners' input is evaluated and the learning is mainly explicit with attention to the word form and meaning), and
4. dedicated lexical applications (e.g., applications that cover all four phases involved in learning (as shown in Figure 4)) (Ma, 2017, p. 50).

The discussed model and framework (memory-based strategic model for vocabulary learning model, and framework for technology-mediated L2 lexical applications learning) and explicit strategy instruction recommendation by Ma (2013, 2014, 2017) were utilised to inform the work developed in this thesis. Accordingly, the aim was to design the web application within the dedicated lexical applications category to provide learners with initial learning contexts (e.g., the KWM training and examples) and subsequent rehearsal (i.e., several recall occasions) to encourage best practices and strategy learning as suggested by Ma (2017).

2.4 Strategy Instruction in CALL

Similar to traditional language learning, strategy instruction is considered a crucial task in CALL (Hubbard, 2013). Strategy instruction (development of metacognitive and self-regulation skills) in CALL can promote learner autonomy (Averill et al., 2000; Warschauer et al., 2000) as it helps the learners with "the time, the pace, the path to the goal, and the measurement of success." (Healey, 1999, p. 400). Other scholars have considered learners' autonomy and self-regulation as a merit of CALL for strategy instruction as well (e.g., Gillespie & Gray, 1992; Moulden, 1986).

The connection between FL acquisition theory and CALL is usually discussed considering Krashen's monitor theory and information processing theory (Bull, 1997; Doughty, 1982; McLaughlin et al., 1983). Some researchers including Bull (1997) and Doughty (1982) outlined that computer use (CALL) for delivering instruction and collecting data helps with precision and control. Furthermore, language learning via CALL platforms should encourage language structure acquisition and strategy control for learners (Fleissner et al., 1991).

Five principles of learner instruction in CALL were outlined as

1. experience CALL yourself,
2. give learners teacher training,
3. use a cyclic approach,
4. use collaborative debriefings, and
5. teach general exploitation strategies (Hubbard, 2013, pp. 51–56).

In the current study, Hubbard's (2013) study principles referred to

1. The educator (researcher) trying the CALL platform as the first user (e.g., the web application was tested by the researcher before providing it to the learners),
2. providing some general advice so learners can connect the CALL activity with desired learning outcomes (e.g., learning strategy instruction training so the learners learn the learning strategy),
3. learners achieving a certain level of comfort with the CALL application before effective use of the application (e.g., via teaching the technical aspects of CALL in small chunks, for instance, the web application demonstration and training sections facilitated this), and
4. providing strategies to help students with utilising learnt material for other purposes (e.g., explicit learning strategy instruction tutorial section in the web application to utilise the learning strategy for vocabulary learning).

Although use of CALL as a strategy instruction instrument has a wide scope, the focus in the present study is on the web application training for learners learning a vocabulary learning strategy (the KWM) and utilising that strategy via the web application to learn and recall words. The KWM has been studied for classroom or

self-study contexts via different approaches, but most studies were based on traditional P&P strategies. For the present research study, the discussed models and theoretical frameworks discussed in sections 2.3.1 and 2.3.2 along with Hubbard's principles (2013) were reviewed and applied to help with the KWM implementation for the developed web application.

In regards to the FRAME model (Koole, 2006, 2009; Koole & Ally, 2006), device usability and the KWM were the device and instructional/learning aspects, respectively. As discussed in section 2.3.1,

a) device and learning considerations helped with anywhere anytime information access in the web application,
b) device and social considerations helped with user collaboration and connectivity design,
c) learning and social consideration helped with culturally acceptable features of the web application, and
d) device, learning, and social considerations as a whole helped with learning tasks and web application designs (Koole, 2006, 2009; Koole & Ally, 2006).

Regarding considerations for a memory-based strategic model for vocabulary learning (Ma, 2014, 2017), the discussed phases in Ma's (Ma, 2013, 2014, 2017) study were facilitated by the KWM while explicit KWM encoding and retrieval instructions were provided to the relevant participant groups while providing required visual and textual inputs for vocabulary learning and recall.

2.5 The Web Application

The current research study required designing and development of a web application. The primary device type used was a browser (on a PC). The following subsections will discuss the literature on software (web application) architecture, prototyping rationale, usability and UX, UI, and user interaction design.

2.5.1 Software Architecture Design in Learning Platforms

Scholars have defined software architecture differently. Bass et al.'s (2003) definition of software architecture is "the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the

relationships among them" (p. 21). To follow best practices in software architecture design in the learning environment in the current research study, a number of software architecture design approaches were reviewed (e.g., model driven architecture, n-tier architecture, and service-oriented architecture).

Fang and Sing's (2009) collaborative learning service-oriented software architecture consisted of

a) application user interface,
b) business processes,
c) services, and
d) service component layers to encompass
    i. user perspectives and interaction,
    ii. indication of implemented activities in services and service component layers,
    iii. required software services and their re-use (where possible), and
    iv. required services.

Zhou et al.'s (2008) e-learning software architecture had several layers including

a) application,
b) software product,
c) application framework, and
d) a component library layer to facilitate
    i. integration of already implemented e-learning software resources with the software,
    ii. manufacturing functionalities,
    iii. content presentation and management, user interface management, and access control, and
    iv. software libraries for e-learning implementations.

Antoniadis et al.'s (2004) prototype was proposed for language learning with a natural language processing (NLP) assisted automatic exercise feature; their multi-layered software architecture included script, activity, function, and scenario levels to provide teachers with an authoring system for defining leaning scenarios with some activities.

Zwicklbauer et al.'s (2015) smart learning software architecture contained a three-tier model of

a) user interface,
b) middle-ware, and
c) data storage layers to incorporate
    i. learning apps, tests, course editors, and so on,
    ii. learning analytics and data exchange software, and
    iii. database and learning objects repository.

Bushehrian and Khaldar's (2011) software architecture for their e-learning system included three layers of

a) learner interaction,
b) labelled transition system explorer, and
c) recommender component with workflow engines repository for learners' activity storage and analysis.

With respect to relevant standards for the current research study, the relevant IEEE Learning Technology Standards Committee (LTSC) technical and software architecture standards regarding education were reviewed. The international standard (ISO 25010) for functional suitability which outlined "the capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions" (Bass et al., 2003, p. 66) was utilised. The product quality standards of "ISO/IECFCD 25010: Systems and software engineering – Systems and software product Quality Requirements and Evaluation (SQuaRE) – System and software quality models" (Bass et al., 2003, p. 193) were also taken into consideration for system software product quality check. The system software product quality standard is presented in Figure 5.

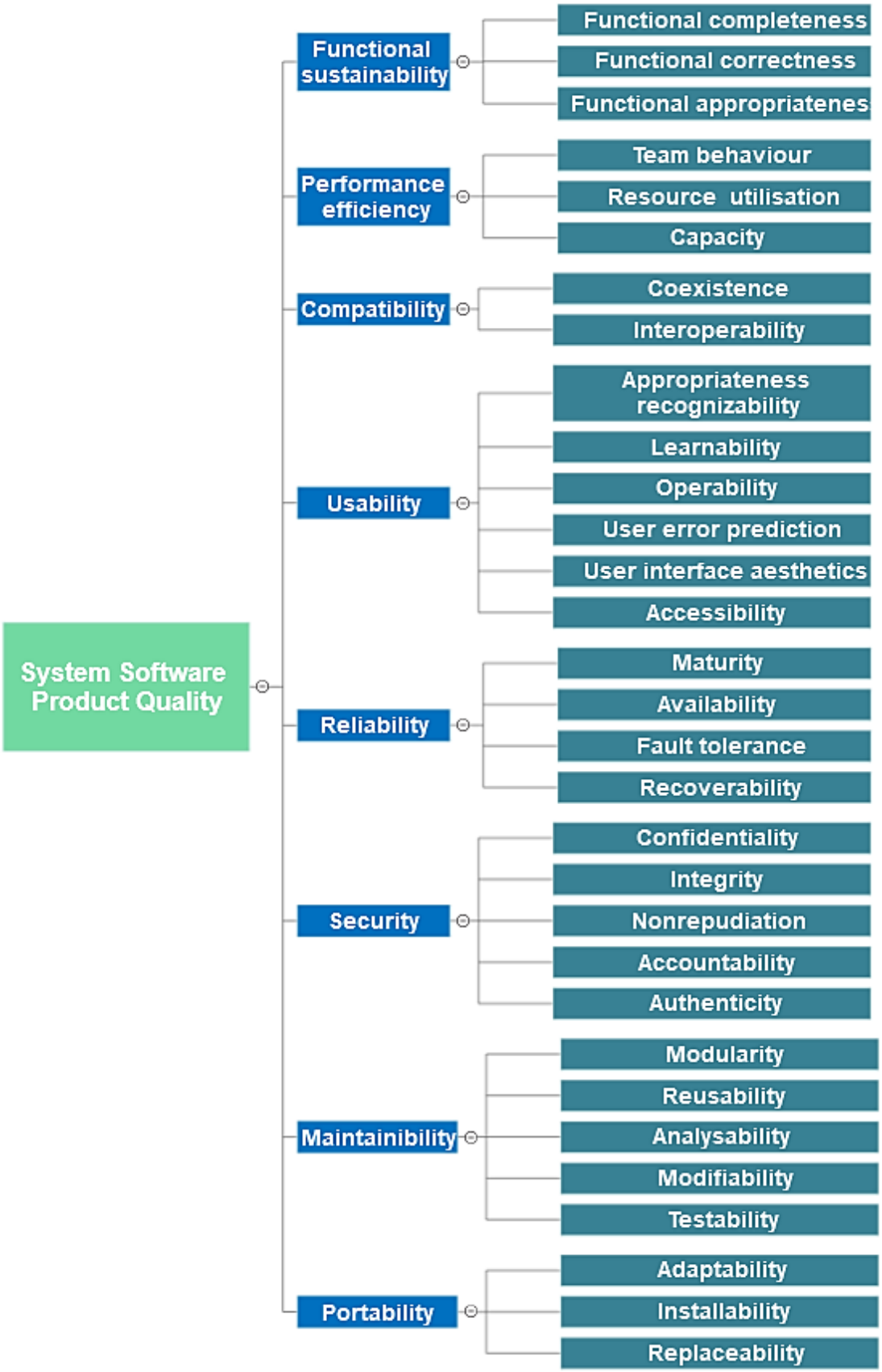


Figure 5. ISO/IECFCD 25010 product quality standards for systems and software engineering (Bass et al., 2003, p. 194)

As shown in Figure 5, the system software product quality standard covers a wide range of software engineering components including functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. As the prototype utilised for the current research study was a web application, some of these elements were already included (for instance, portability and compatibility) while other elements required extra effort to be consistent with this standard (for instance, the security and usability elements).

The prototyping rationale, web application usability, and web application UX, UI, and user interaction are discussed next while the utilised programming languages and technologies, web application sections and flow are discussed in section 3.5.2.

2.5.2 Prototyping Rationale

This section discusses the concept of prototypes and prototyping rationale in an HCI context.

Nissinen's (2015) definition of a prototype is an interactive limited system utilised for analysis, design, and evaluation. Nissinen (2015) counted user requirement comprehension, design idea evaluation, and liaising design decisions as some advantages of prototyping and outlined the variables of filtering and manifestation dimensions in Tables 5 and 6, respectively (adapted from Nissinen (2015, pp. 11, 12) , originally from Lim et al. (2008, p. 7).

Table 5. The variables of filtering dimensions (adapted from Nissinen (2015, p. 11), originally from Lim et al. (2008, p. 7))

Filtering Criteria	Variable Instances
Appearance	Size, shape, structure (form), texture, margin, weight, colour, transparency, proportion, haptic, hardness, gradation, and sound
Data	Type, size, use, organisation, privacy, and hierarchy of data
Functionality	Functionality requirements of the user and the system
Interactivity	Information, feedback, and input behaviour

Filtering Criteria	Variable Instances
Spatial structure	Relationships between interface or information components – which can be two-dimensional or three-dimensional, intangible, or observable, or mixed – and their arrangement

In Table 5, the variable instances for each filtering criteria are shown in the same row (e.g., for the 'appearance' filtering criteria, the variable instances are 'size, shape, structure (form), texture, margin, weight, colour, transparency, proportion, haptic, hardness, gradation, and sound').

Table 6. The variables of manifestation dimensions (adapted from Nissinen (2015, p. 11), originally from Lim et al. (2008, p. 7))

Manifestation Criteria	Meaning	Variable Instances
Material	The medium (visually obvious or hidden) was used to create a prototype.	Tools for manipulating physical matters, such as a knife, scissors, ink, and sandpaper; computational prototyping resources, such as Macromedia Flash and Visual Basic; physical computing equipment, such as widgets and Basic Stamps; usable existing artefacts, such as a beeper to simulate a heart attack
Resolution	The level of complexity or detail that is manifested (corresponding to fidelity)	Accuracy of output, for example, feedback time in response to users' input (feedback on a computer-based prototype is faster than on a paper prototype); details of appearance and interactivity, and actual versus mock-up (fake) data
Scope	The scope of what is to be manifested	Contextualisation level, for instance, website colour scheme testing with only colour scheme charts or colour schemes put in a website layout structure; usability testing of book search navigation with only the book search related interface or the entire navigation interface

In Table 6, the meaning of each manifestation criteria, and the variable instances for each manifestation criteria are listed in the same row.

2.5.3 The Web Application Usability

While the main purpose of the usability measurement is simplifying products and systems to meet user requirements, it is important to perceive the different views in usability measuring to define it properly (Bevana et al., 1991). Bevana et al. (1991) categorised these views into

a) product-oriented (usability measuring in regard with the product ergonomic attributes),
b) user-oriented (usability measuring with user mental effort and attitude considerations),
c) user performance-oriented (usability measuring based on user interaction e.g., product ease of use and acceptability).

According to ISO 9241-11, usability is “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use” (ISO 9241-11:2018: Ergonomics of Human-System Interaction — Part 11: Usability: Definitions and Concepts, 2018, p. 92). Based on this definition, for a website usability evaluation, effectiveness (users’ capabilities to accomplish the tasks successfully), efficiency (required effort to accomplish the tasks), and satisfaction (the extent of users’ happiness at the time of performing the tasks) should be measured.

There are a number of methods to evaluate usability. Iqbal (2015) grouped usability evaluation methods into

a) focus groups (asking multiple users about their feelings related to the test to obtain general information),
b) Nielson’s heuristic evaluation (assigning a severity rating – conducted with no users),
c) face-to-face user interview, and
d) questionnaires (for subjective information collection).

In the current study, participants were asked to complete a paper-based SUS questionnaire to measure the usability of the designed web application. This section discusses the underlying usability requirements of the current research study.

2.5.3.1 System Usability Scale (SUS)

The industry standard SUS questionnaire is an apparatus for assessment of the usability of software systems and was the primary evaluation tool for the usability of the developed web application in the current study. Being introduced in 1986, SUS was developed as a cost-effective and quick usability survey (Brooke, 1996).

A formal rating system was never offered for scores in SUS; however, some scholars have recommended some rating scales for SUS score calculations developed on large SUS data samples (Brooke, 1996). Referred to as an 'adjective rating scale' and 'university grade analogue', Bangor et al. (2008, 2009) based the adjective rating scale system upon collected data of seven-point Likert SUS questionnaires where the questions captured the "adjective rating of a system's user friendliness by asking users to rate it from worst to best imaginable" (Bangor et al., 2008, 2009; Mirzaei et al., 2018, p. 687). The original SUS contained 10 items of mixed tone, with the odd-numbered items in the positive and the other half in a negative with a scale of response ranging from 1 (strongly disagree) to 5 (strongly agree) (J. R. Lewis et al., 2015). This was to reflect psychometric practice standards. However, this alternation could result in negative consequences (J. R. Lewis et al., 2015). Lewis et al. (2015) regarded the negative-tone items replacement with positive ones as useless, while reporting no evident changes in response biases or significantly different responses between the different variations. Thus, in the current research study, the Persian translated positive version of Table 7 below was utilised.

Table 7. The SUS items (standard and positive versions) (adapted from Lewis et al. (2015))

Items	Standard Version	Positive Version
1	I think that I would like to use this system frequently.	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.	I found the system to be simple.
3	I thought the system was easy to use.	I thought the system was easy to use.

Items	Standard Version	Positive Version
4	I think that I would need the support of a technical person to be able to use this system.	I think I could use the system without the support of a technical person.
5	I found the various functions in the system were well integrated.	I found the various functions in the system were well integrated.
6	I thought there was too much inconsistency in this system.	I thought there was a lot of consistency in the system.
7	I would imagine that most people would learn to use this system very quickly.	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.	I found the system very intuitive.
9	I felt very confident using the system.	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system.	I could use the system without having to learn anything new.

In the current study, usability principles were in line with Mirzaei et al. (2018) and Sauro/Lewis' curved grading scale (J. R. Lewis et al., 2015) was employed to provide an 'empirically grounded approach' for the interpretation of mean SUS scores (Lewis et al., 2015). In Figure 6, the terminology outlined by Lewis et al. (2015) is shown in a Sunburst chart format.

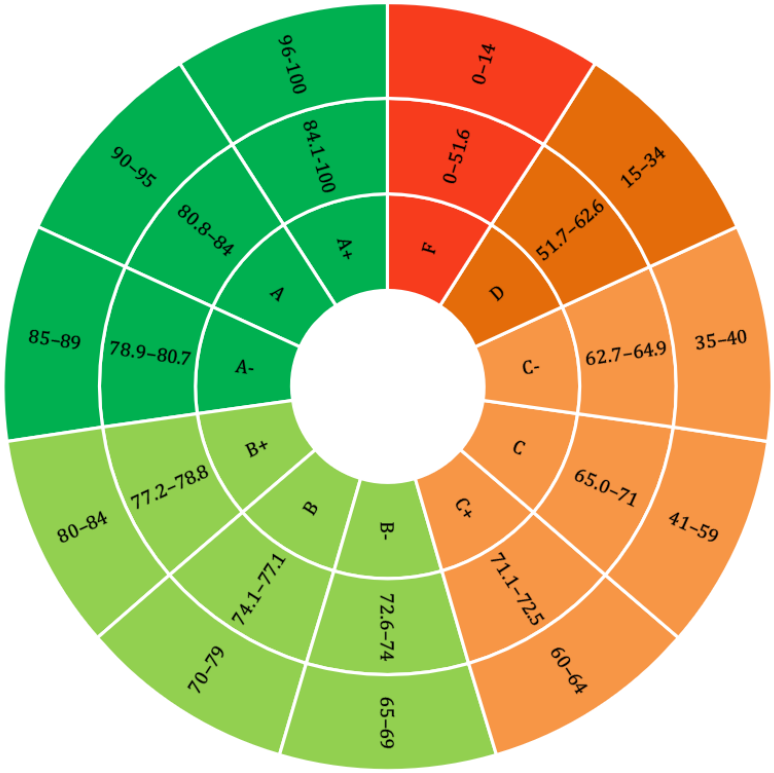


Figure 6. The Sauro/Lewis curved grading scale sunburst chart (adapted from Lewis et al. (2015))

In Figure 6, the most outer layer is showing the 'SUS score range' while the middle and most inner layers are showing the 'percentile range' and 'grade', respectively (adapted from Lewis et al. (2015)).

In current research study, SUS is utilised to discuss subjunctive usability measures (Brooke, 1996). Robertson (2018) considered SUS an appropriate subjective usability measure for its numerous features as shown in Table 8.

Table 8. Features of SUS as a subjective usability measure (adapted from Robertson (2018, pp. 10–11))

Feature(s)	Outcome(s)	Research Indicating the Feature(s)
Being non-proprietary	Easily accessible	1. Gao's (2017) study titled "Measuring the Usability of Home Healthcare Devices"
Being technology agnostic	Able to evaluate a large range of products	1. Brooke's (1996) study titled "SUS-A Quick and Dirty Usability Scale" 2. Brooke's (2013) study titled "SUS: A Retrospective"

Feature(s)	Outcome(s)	Research Indicating the Feature(s)
Reliability	Being a psychometrically validated instrument	1. Bangor et al.'s (2009) study titled "Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale" 2. Lewis and Sauro's (2009) study titled "The Factor Structure of the System Usability Scale"
Short administration times	Quick scoring	1. Kortum and Sorber's (2015) study titled "Measuring the Usability of Mobile Applications for Phones and Tablets"
Unidimensional (no subscales)	final score represents a single measure of subjective usability	1. Brooke's (1996) study titled "SUS-A Quick and Dirty Usability Scale" 2. Lewis and Sauro's (2017) study titled "Revisiting the Factor Structure of the System Usability Scale"

In Table 8, the features of SUS as an appropriate subjective usability measure are listed along with the outcome of such features and the studies indicating these features and outcomes (Robertson, 2018).

Robertson (2018) considered four methods for measuring usability in SUS on the basis of available literature

a) use-then-measure,
b) retrospective,
c) prospective, and
d) watching others.

According to Robertson (2018)

a) use-then-measure method is utilised forthwith after using the product by asking the participants to engage in the pre-arranged task under controlled settings so that the researcher could collect the usability ratings afterwards,

b) retrospective method as the name implies is carried out after product use by asking the participants to evaluate the product subjectively while this evaluation may not occur immediately after product use,
c) prospective method is carried out prior to product use by asking the participants to judge the usability of the product visually (e.g., seeing screenshots of the product environment) based on a set of usability principles, and
d) observation method is watching others method is conducted by presenting the video recording of other users working with the product to the participants and ask them to rate the product usability based on their observations (of users' interaction with the product) in the video recording.

The current research study used the retrospective approach for subjective usability testing after a comprehensive review of different methods was conducted.

2.5.4 The Web Application UX, UI, and User Interaction Design

In the design of the web application for the current study, the centre of attention was on user friendliness and simplicity. Accordingly, a number of previous studies in the literature on UX, UI, and user interaction design are discussed in the current section. UX and usability are closely knitted together (McCarthy & Wright, 2004) with the UX subjectively focusing on users' experience of the product while the usability is objectively focusing on task performance and completion. UX definition varies; however, three aspects are common in most of the definitions

a) user,
b) system, and
c) context of use (Roto et al., 2011).

In the current research study's web application UX,UI, and user interaction design, principles and usability attributes by Nielsen (1994) including

a) efficiency (focused on users' goal achievement),
b) satisfaction (focused on product usage),
c) learnability (focused on user friendliness),
d) memorability (focused on remembering the system after a period of time without needing to learn it again), and
e) errors (focused on recovery from errors)

were linked with Harrison et al.'s (2013) cognitive load principle of pedagogical/technology disadvantage avoidance. The preceding review of the web applications focusing on UX orientation and Norman's (2016) features of

a) meeting precise user requirements and
b) elegance and simplicity enforcement

were regarded as the core of the UX design. Figure 7 shows the UX factors in the current study based on Nielsen's (1994), Harrison et al.'s (2013), and Norman's (2016) studies.

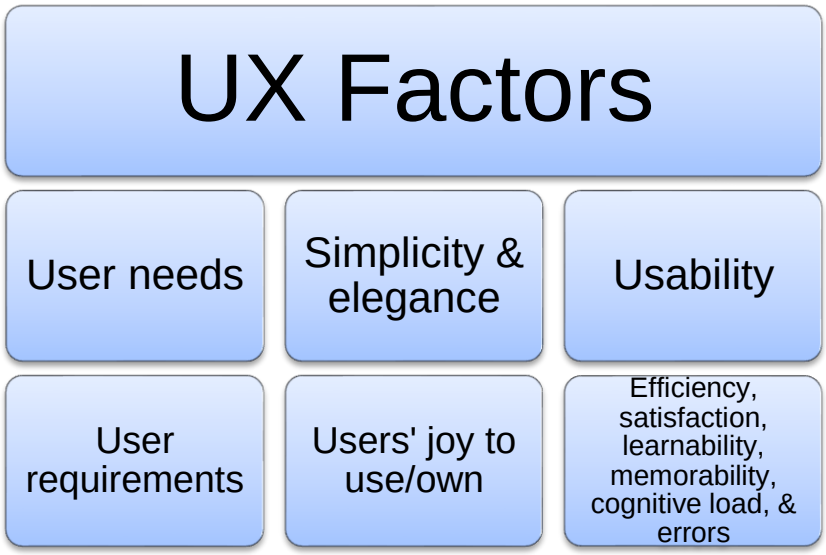


Figure 7. UX factors and what they address in this study (adapted from Nielsen's (1994), Harrison et al.'s (2013), and Norman's (2016))

For UI design, Garrett's (2010) strategy of embedding suitable interface elements to encourage user accomplishment (of the desired task(s)) was applied. A simplified interface with standard buttons and texts was used to avoid extra cognitive load. Some of the factors considered to improve the usability and learnability of the web application were typography, spacing, text style and arrangement, shapes and texture, consistency and utility, font size and visual hierarchy, and colour and contrast between colours (Valoris, 2015). Figure 8 shows the UI criteria in the current study.

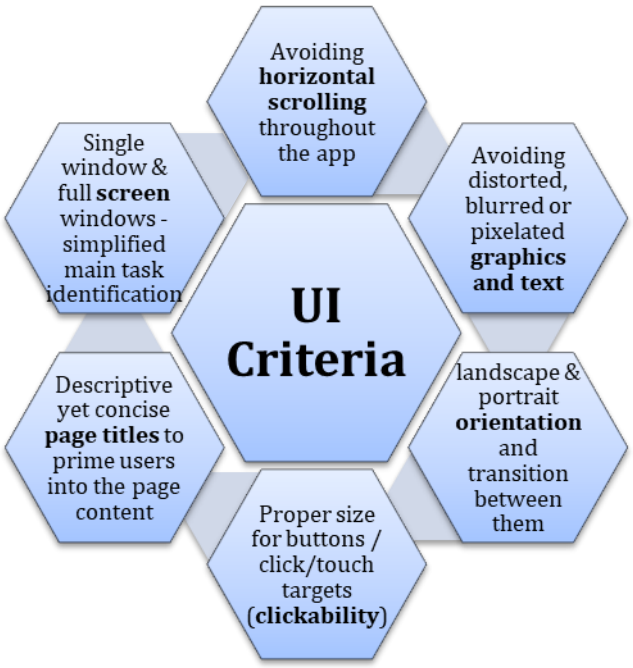


Figure 8. UI criteria considered in this study (adapted from Valoris (2015))

Rogers et al. (2011) designated interaction design as a necessity for products and services design to reach suitable usability standards and recommended the following model for the interaction design lifecycle (Figure 9).

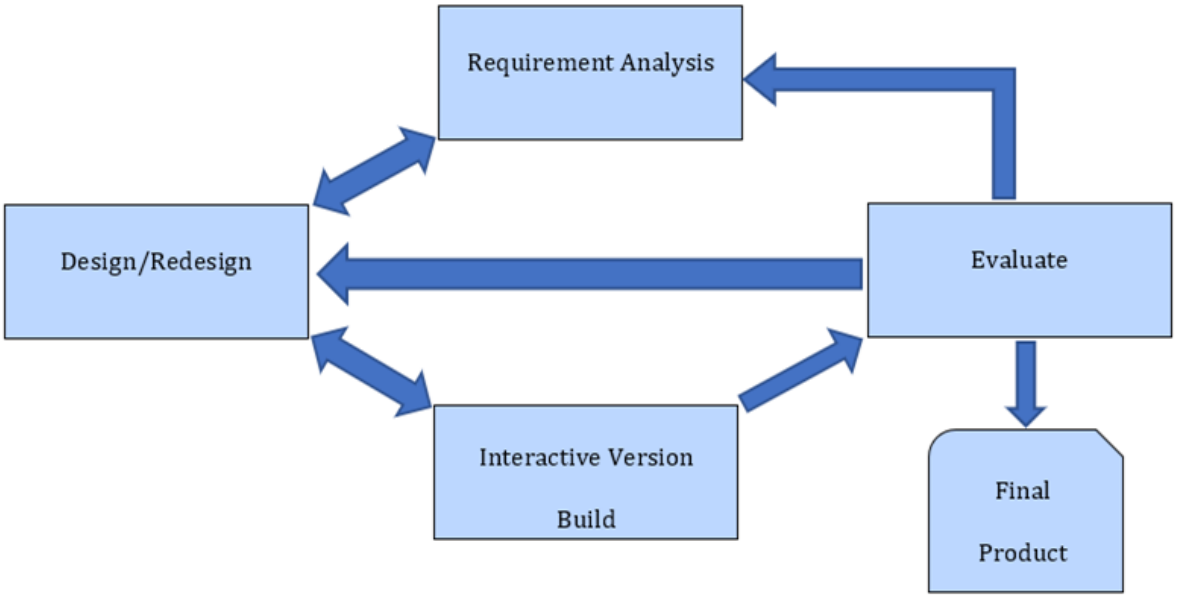


Figure 9. Interaction design lifecycle model (adapted from Rogers et al. (2011))

Based on this model, the process of interaction design includes four iterative phases

1. UX requirements identification and establishment (Requirement Analysis),
2. design and development based on the requirements in phase 1 (Design/Redesign),
3. communication and assessment of the interactive design version after building it (Interactive Version Build), and
4. evaluation of UX and what is being produced throughout the process (Evaluate) (Rogers et al., 2011).

All layout elements corresponding to different web application sections (i.e., learning, testing and authentication/signup) had the same UI, UX, and user interaction designs for simplicity and consistency reasons. The colour used for background of the web application was white while black was the primary colour for text elements. For gaining user attention, a light-colour highlight was utilised (i.e., the keyword highlighting). To simplify main task identification and to show the focus of the web application, text elements were positioned at the top left of the screen. The dynamic timer responsible for countdown was embedded in a graphical bar and placed at the top centre of the screen above the text elements to show the current state of the web application and the transition between scenes to the users. Buttons were used when necessary (mainly for signup and authentication and returning to home page where allowed) for a simplified user interaction. Appropriate colour and colour contrast were utilised for UI buttons to help with actionability and click-ability while considering other factors such as shape, size, placement, and padding. To satisfy the KWM strategy requirements and distraction/cognitive load reduction, elements such as undistorted graphics/text, breadcrumbs, back button navigation, and actions like horizontal scrolling were disabled in learning and testing sections of the web application.

2.6 Research Questions

The following research questions (RQ) were considered for this study

RQ1: Will the use of the KWM improve vocabulary learning outcomes?

RQ2: Will different KWM instruction methods affect vocabulary learning with KWM in different experimental groups?

RQ3: Will the KWM affect vocabulary learning short-term and long-term recall?

RQ4: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions)?

RQ5: Is the designed web application for this study usable?

2.7 Chapter 2 Summary

The chapter focused on the literature relevant to this research study.

In this chapter, in section 2.1, vocabulary learning including its importance, self-regulation, vocabulary learning strategies, memory and vocabulary learning processes in the brain, strategy instruction, and cognitive load were discussed. After outlining the importance of vocabulary learning (section 2.1.1), it was important to discuss self-regulation (section 2.1.2) and the different vocabulary learning strategies (section 2.1.3), with a focus on the KWM (section 2.1.3.1) definitions, underpinning learning theory and information processing. This helped to further discuss the requirements for the strategy training and vocabulary learning and testing phases in the web application in the coming sections. Explicit and implicit learning along with intentional and incidental learning definitions were also considered to discuss the reasons behind utilising explicit strategy (the KWM) instruction and having intentional learning tasks for vocabulary learning purposes in the current study. Furthermore, the reasons for consideration of the relevant recommendations by the literature were discussed (e.g., the reason for utilising concrete high-vividness word-pairs along with experimenter-generated keywords in the present study as suggested by the previous literature). Also, in section 2.1, memory retention (section 2.1.4), three main phases for memory processing and retrieval, and discussed declarative long-term memory classifications and vocabulary learning process in semantic memory were further discussed. Next, strategy instruction in vocabulary learning was discussed in section 2.1.5 while the concepts of cognitive theory of multimedia learning (Figure 2) and multimedia learning principles (Table 2) and their application to the current research study (section 2.1.5) were discussed in detail. In designing the learning environments for the current study, all cognitive load types were considered so that the progress of learning could be maximised using the full capacity of working memory. As ICL is pre-established, optimisation of ECL (ECL reduction) could help with maximising the resources for GCL

(increase in GCL) (Sweller et al., 1990; van Merriënboer & Sweller, 2005). One of the main reasons of mnemonic strategies' effectiveness is the organisation of the information in memory and how the underlying structures hold together the details and the help with the information recall (Manis, 1966). Mnemonic strategies benefit from information association and classification to provide an organised structure (Eysenck, 2001). What is more, the visual imagery usages in mnemonic strategies (e.g., in the KWM) improves both learning in various contexts (Eysenck, 2001) and the memory itself; because imagining the information to remember it (encoding strategy e.g., in the KWM) can improve memory capabilities (Magnussen & Helstrup, 2007). A number of scholars considered image generation as an efficient strategy for encoding (e.g., Agramonte & Belfiore, 2002; Anderson, 2005; Cramer, 1981; Levin et al., 1973)

In section 2.2, background studies on CALL including CALL use in vocabulary learning, CALL effectiveness, challenges, learning theories, and CALL use in Persian studies were presented. In section 2.2.1, an investigation of current application and software platforms utilised for vocabulary learning was conducted to identify if the KWM and its explicit strategy instruction were features of these application and software platforms. These many platforms offer tutorials, exercises, videos, chat options, and other types of communication in a variety of languages and are built on one or a number of the teaching and learning strategies; however, only Linkword employs the KWM; others, such as Memrise, Pictoword, VoLT, Supermemo, and MosaLingua, employ principles that are related to the KWM to some extent. Additionally, none of these applications, including Linkword, employed the KWM with proper explicit strategy instruction. As a result of this review, it was decided to develop a web application that followed the required explicit instruction principles. One of the main reasons to embed the KWM in the web application in the current study was to motivate learners through technology use (e.g., Derakhshan & Khodabakhshzadeh, 2011). In the current research study, the KWM was chosen for the possibility of implementing it in a CALL-based environment and for its many benefits and merit.

Next, the theoretical frameworks include Koole's FRAME (Koole, 2006, 2009; Koole & Ally, 2006) and Ma's memory-based strategic model (Ma, 2014, 2017) (section 2.3), strategy instruction in CALL with a focus on the KWM (section 2.4) were discussed.

The web application including the software architecture design, prototyping, usability, UX, UI, and user interface design and RQs were presented in section. 2.5 and 2.6.

Chapter 3 discusses the methodology devised to explore FL using KWM and CALL based on the literature review in this chapter.

3 METHODS

This chapter discusses the methods used in the current research study along with the participants, procedures, materials, tools, and data collection, analysis, and preparation to facilitate the study design.

The study design is discussed in detail in the section 3.1. This is followed by a description focussing on the participants in the section 3.2. The procedures, material and tools, data collection and methods of data analyses, and data preparation are presented next. The final section (section 3.8) presents the chapter summary.

3.1 Methodology and Study Design

Choosing appropriate research methods and theoretical frameworks ensures that the study design will facilitate addressing research aims (Appleton & King, 2002). For instance, this can assure “the accomplishment of research aims” (Robey, 1996, p. 406).

The current study aimed to evaluate the efficacy and usability of using computer devices to learn a learning strategy new to the learners and new FL words using an experimental design. A mnemonic vocabulary learning strategy (the KWM) was implemented within a web application for this purpose. A browser (on a PC) was the main delivery tool of focus for the study, and the traditional ‘pen and paper’ (P&P) was included as a means of comparison as it represents a commonly used strategy in the KWM. Two control groups were used in this study: one using the P&P and the other using the web application to learn new vocabulary without being introduced to the KWM.

The broad aims of this study were to

a) design a web application that can support delivery of the KWM strategy instruction, vocabulary learning component and vocabulary testing component, and to examine its usability,
b) investigate whether there is an advantage for learners to use this web application for learning new word-pairs,

c) examine the effectiveness of the KWM strategy on vocabulary learning as delivered via a traditional P&P based learning approach vs with the web application learning.

A number of empirical predictions were considered in the current study based on prior research findings (Mirzaei, 2016; Mirzaei et al., 2018). However, these prior research studies (Mirzaei, 2016; Mirzaei et al., 2018) were aimed at English learners learning rare English words and the focus of these studies were on usability of the mobile application rather the learners' vocabulary recall. Accordingly, in the present study, the hypothesis was that the learners who use an app method (the web application) in both control and experimental groups obtain better vocabulary test results overall and follow an upward trend in each test occasion (i.e., immediate and delayed recall) as the app method was the preferred method in the previous studies (Mirzaei, 2016; Mirzaei et al., 2018). Also, it was predicted that the words studied in the groups with the keyword encoding/explicit instruction interventions would show better results than the other groups no matter on an app or traditional P&P methods. Distinct from the prior research studies (Mirzaei, 2016; Mirzaei et al., 2018), in the current longitudinal study (29 days), four occasions of testing, two word-sets of 22 word-pairs, a newly designed web application on a different platform, different language (English-Persian), and bidirectional recall tests were utilised.

As the experiments were based on Mirzaei et al. (2018) and Wyra et al.'s (2007) studies, participants in experimental groups were presented with information on different interventions including the KWM encoding, explicit instruction, and retention and recall procedures either via a technology-based environment for app methods (i.e., video training within the web application) or with hard copy booklets. For the control groups, the participants were asked to use their own strategy of learning. The word-sets were selected by considering parts of speech (all nouns) and syllables and all groups received exactly the same order of words in all learning and test occasions as recommended by Fritz et al. (2007). It is also recommended by Pressley (1977) that concrete-meaning keywords are utilised to help with production of imaginable interaction of English word and the keyword, while the chosen words-to-be-learnt and keywords were simple in meaning and structure.

The current research study included three independent experimental study components. Components 1 and 2 of the study focused on vocabulary learning and testing via the KWM while component 3 of the study focused on usability of the designed web application through a SUS questionnaire.

As discussed previously, new technologies employed in FL education has led to the emergence of the field of CALL (Lin et al., 2016). To utilise CALL in the current study, the following needed to be embedded in the developed web application (CALL-based environment to utilise CALL for vocabulary learning via the KWM) and P&P booklets

a) teaching the learning strategy; (the KWM); explicit instruction was facilitated by the use of training tutorial and demonstration videos for app groups, and booklets were used for the P&P groups. Teaching of the KWM included providing modelling of how to use the KWM to learn new vocabulary and practice (learning and testing example word-pairs),
b) learning new word-pairs; this was facilitated through the learning section in the designed web application for the app groups, and in the word learning paper booklets for the P&P groups,
c) testing the recall of words; the vocabulary testing section was used for data collection and the required statistical hypothesis testing to answer the research questions regarding immediate (one occasion) and delayed (three occasions) recall of learnt word-pairs. This was facilitated through the testing section in the designed web application and P&P booklets.

In the current study's quantitative, experimental research design, the independent variables are the time, word-sets 1 and 2, and the strategy (different outcome for different strategies) for

a) web application based KWM (app)
b) traditional KWM (P&P)
c) control (ctrl) (learners' own/usual vocabulary learning strategy).

3.1.1 Experiment

The experiment in the present study included three components each of which were facilitated by some of the experimental study five phases as presented in Table 9. Through phases (0-2), component 1 of the study aimed to facilitate the learning and

utilisation of a strategy (the KWM for experimental groups and own strategy for control group) and learning and testing immediate and delayed recall of word-set 1 word-pairs. Component 2 of the study included phase (3) and aimed to facilitate the learning and testing immediate and delayed recall of word-set 2 word-pairs without repeating the intervention (phase (1)). Component 3 of the study included phase (4) and aimed to gather feedback on the usability of the web application.

The same participants (within study design) were engaged in components 1,2, and 3 of the study in six different groups (between study design) but on different days. The research discussed in this thesis was adopted from Wyra et al.'s (2007) study; however, it differs from Wyra et al.'s (2007) study as in their study, English learners learned Spanish via the KWM (on P&P) while in the current study **Persian** learners learned English (on P&P and **the web application**). It is worth pointing out that the Persian language has orthographical, phonological, and syntactical differences to Spanish (and other Latin or Germanic languages).

Table 9. The experimental study design phases for components 1, 2, and 3 of the study

				Control Groups		Experimental KWM App Groups		Experimental KWM Traditional P&P Groups	
Day	**Materials**	**Phase**	**Activity↓ Group→**	**ctrl (P&P)**	**ctrl (app)**	**KWM - enc (app)**	**KWM - ret (app)**	**KWM - enc (P&P)**	**KWM - ret (P&P)**
Phase 0 (component 1 of the study)									
1	-	0.1	Background (demographics, age, gender, computer device familiarity) questionnaire (~5 mins)	√	√	√	√	√	√
1	-	0.2	Study Procedures Demonstration (video/booklet) (~5 mins)	√	√	√	√	√	√
Phase 1 – Intervention (component 1 of the study)									
1	-	1.1	Explicit instruction & encoding tutorial (video/booklet) (~10 mins)	NA	NA	√	√	√	√
1	-	1.2	Explicit instruction & encoding and retrieval tutorial (video/booklet) (~5 mins)	NA	NA	Discussion about example words	√	Discussion about example words	√
1	-	1 .3	Distraction (3 mins)	√ (chat)	√ (chat)	√ (chat)	√ (chat)	√ (chat)	√ (chat)
Phase 2 - word-set 1 (learning and testing) (component 1 of the study)									
1	1LWS1	2.1	Learning word-set 1(22 words in 7.5 mins)	√	√	√	√	√	√
1	-	2.2	Distraction (3 mins)	√ (chat)	√ (game)	√ (game)	√ (game)	√ (chat)	√ (chat)

1	1TWS1	2.3	Test 1 for word-set 1 (5 mins)	√	√	√	√	√	√
5	2TWS1	2.4	Test 2 for word-set 1 (5 mins)	√	√	√	√	√	√
9	3TWS1	2.5	Test 3 for word-set 1 (5 mins)	√	√	√	√	√	√
13	4TWS1	2.6	Test 4 for word-set 1 (5 mins)	√	√	√	√	√	√
Phase 3 - word-set 2 (learning and testing) (component 2 of the study)										
17	1LWS2	3.1	Learning word-set 2 (22 words in 7.5 mins)	√	√	√	√	√	√
17	-	3.2	Distraction (3 mins)	√ (chat)	√ (game)	√ (game)	√ (game)	√ (chat)	√ (chat)
17	1TWS2	3.3	Test 1 for word-set 2 (5 mins)	√	√	√	√	√	√
21	2TWS2	3.4	Test 2 for word-set 2 (5 mins)	√	√	√	√	√	√
25	3TWS2	3.5	Test 3 for word-set 2 (5 mins)	√	√	√	√	√	√
29	4TWS2	3.6	Test 4 for word-set 2 (5 mins)	√	√	√	√	√	√
Phase 4 – SUS (component 3 of the study)										
29	-	4.1	SUS questionnaire (only app groups) (~ 10 mins)	NA	√	√	√	NA	NA

In Table 9, some codes are used in the 'Material' column to indicate what was done at each phase. In these codes, the starting number was referring to the testing or learning occasion/s; the letter 'L' and 'T' stood for Learning or Testing vocabulary while 'WS' was referring to the Word-Set number. For example, '1LWS1' was the instance 1 of learning word-set 1 while '1TWS1' was the first instance of testing word-set 1. Also, only encoding groups are shown by 'KWM - enc (app)' and 'KWM - enc (P&P)' while encoding and retrieval groups are presented by 'KWM - ret (app)' and KWM - ret (P&P)' columns.

3.1.2 Phases

This study included five phases (phases 0-4) as presented in Table 9. In Table 9 the '√' shows the activity was done and the 'NA' shows the activity was not applicable to the study group (i.e., for the 'ctrl' P&P and app groups, no explicit instruction activities (intervention) were applicable). All five phases in this study were based on Wyra et al.'s (2007) and Mirzaei et al. (2018) studies.

Phase (0) aimed to collect participants' background information and demonstrate study procedures. This phase included a background questionnaire (phase 0.1) and the study procedures demonstration either via a video for the app participants or via a booklet for P&P participants (phase 0.2).

Phase (1) which was the intervention phase included either the KWM explicit instruction and encoding or the KWM explicit instruction and encoding and retrieval tutorials along with the distraction for the relevant experimental groups before phase (2). As shown in Table 9, only encoding (KWM - enc (app) and KWM - enc (P&P)) and encoding and retrieval (KWM - ret (app) and KWM - ret (P&P)) group participants received the strategy training tutorial (encoding (phase 1.1) or encoding and retrieval trainings (phase 1.2)) while the distraction (phase 1.3) which was a non-relevant chat activity was included for all participants.

Phase (2) included learning of the word-set 1 word-pairs (phase 2.1) and the distraction in the form of a game for app groups or in chat format for paper-based P&P groups (phase 2.2), and the four occasions of testing the words recall (phases 2.3, 2.4, 2.5, and 2.6) as required by the study design principles of Wyra et al.'s (2007) study. In phase (2), control group participants learnt word-set 1 word-pairs by

themselves using their own methods while experimental group participants utilised the KWM to learn the word-pairs and all participants' bidirectional (forward, i.e., English to Persian and backward, i.e., Persian to English) recall of the learnt words was tested on the mentioned four occasions. The first occasion was for immediate recall and the other three occasions were for delayed recall.

Phase (3) followed the same procedures as phase (2) but with a different word-pair (word-set 2). The main purpose of phase (3) was to test participants recall without repeating the intervention (phase (1)).

Phase (4) which was only applicable to the app participants, aimed to check the web application usability and learnability via a SUS questionnaire. An SUS questionnaire was completed by both control and experimental app group participants to gather feedback on the usability of the web application.

3.2 Participants

This research study was carried out at a tertiary education institution and a vocational language learning institution with 240 participants. The age of the participants ranged from 18 to 60 and the participation required them to have a basic or below basic English level. The level of English proficiency requirement was checked at two instances by asking the participants and checking with the aforementioned institutions; once, after the participants responded to the mass recruitment email (Appendix IV), and the second time, at question 4 of the background questionnaire (Appendix V).

The participants' involvement was voluntary. Participants were contacted via the recruitment email and the information pack email was sent back to those who indicated their interest to be involved in this study. Participants were informed that their participation was confidential, their names would not be used in any resulting, reports or publications, and that they can withdraw from the study without any consequences at any time. Consent forms and information sheets used in this process are available in Appendix (I) and (II), respectively. The application to conduct the research as outlined here was approved by the Flinders University Social and Behavioural Research Ethics Committee (SBREC, Project ID: 8374). The SBREC approval notice is available in Appendix (VIII). Accordingly, permissions were obtained from the two institutions from which students were recruited for this study.

Participants were made aware of the expected time commitment and location of this study via WhatsApp, Telegram, or email communications. Participants needed to be at least 18 years of age. No prior experience with handheld or computer devices was necessary. Participants could agree to their engagement by responding to the email with their preferred session times. They also needed to complete the attached consent form to the sent email. Then, participants received a confirmation email with session booking details, which included the times and the location of the sessions. Participants were asked to bring the completed consent forms with them to the training session. Participants were made aware that the results of this study were to be published in journals, conference presentations, associated articles, and included in the researcher's research project thesis.

Although the experimental groups participants only received the training on the KWM during the experiment, at the end of the experiment, the control group participants had the opportunity to acquire the same training.

3.3 Procedures

Participants were randomly assigned to all six study groups (40 participants in each).

The components 1, 2, and 3 of the experimental study were done in groups under the researcher's supervision. Participants worked independently from phase 0 to the end of phase 4. The experimental groups learned the KWM which they were asked to apply to learn and then recall a set of new English words (word-set 1) using the web application or in the traditional way (P&P) or using their own learning methods on the web application or in the traditional way (P&P). As shown in Table 9, a within-and between-subject design was used in this experiment with two groups of participants to control for the order of interventions (KWM versus Control) and two methods (app versus P&P). The number of correct recalled words and SUS scores were the dependent variables for both within and between study designs while the between factors were the test occasion times (T1, T2, T3, and T4), the encoding strategies (encoding vs encoding and retrieval), methods (P&P vs app), and word-sets (for word-set 2, no strategy training was provided).

In the learning and testing phases for all groups, the same number of words were used in each of the methods (2 x 22 - word-pairs word-sets). As previously mentioned, the

words were controlled for the type and length of words (2–3 syllable concrete meanings nouns). The order of which method to do was chosen pseudo-randomly to remove any potential bias. In the learning and testing phases, no images were shown to the user in the web application or booklets, as the learner was required to create a mental image relating the meaning and the keyword which was provided for learners, based on van Hell and Mahn's (1997) findings. As discussed previously, van Hell and Mahn (1997) stated that the KWM is effective no matter how the keyword is provided; that is, whether it is being provided by the experimenter or being generated by the learner.

For the vocabulary learning phase, learners in the experimental group used the KWM to learn new English words and their Persian meanings (word-pairs) while control group learners used their own method. Learners' recall of newly learnt words and their meanings was tested in the vocabulary testing phase. More specifically, in learning and testing phases, word-set 1 word-pairs, and word-set 2 word-pairs were used for components 1 and 2 of the study, respectively (22 word-pairs in each word-set - first 11 for forward recall and the latter 11 for backward recall). This captured the key aim of this study: testing the student learning of the newly learnt words via the KWM within the designed web application or P&P booklets. The purpose of component 2 of the study was to see whether the participants remember the strategy trainings and check their recall, accordingly. The developed web application followed the same procedures as the traditional version of the KWM instruction, along with some extra features

1. highlighting the keyword, while word-pairs were shown in a timely manner and
2. a bar timer was shown to the user for indicating how much time was left to learn each word-pair.

The study design required the participants to be distracted between learning the words and being tested on their recall. For this purpose, the participants in P&P methods were engaged in a casual conversation not related to the learning task while app method participants were engaged in a short, low cognitive load task within the web application; the user was asked to click on the green cell on the screen while the green cell's position on the screen was changing constantly. The distraction in both methods took the same amount of time (3 minutes).

For component 3 of the study, an SUS questionnaire was completed by both control and experimental app group participants. In the current study, SUS questionnaires were provided to participants, so the usability of web application was measured by participants of the app groups. In this SUS questionnaire, the term ‘app’ was used instead of ‘system’ (original phraseology) to better reflect what was being assessed. The questions used in the SUS questionnaire were the positive version as shown in Table 7.

The time commitment for each phase of the study is shown in Table 10.

Table 10. Time commitment for each participant

Phases of Research	Expected Time Commitment	Study Component
Phase 0: background questionnaires and study procedures demonstration	~10 minutes	Component 1
Phase 1: Intervention	~20 minutes	Component 1
Phase 2: learning and testing word-set 1	~30 minutes	Component 1
Phase 3: learning and testing word-set 2	~30 minutes	Component 2
Phase 4: SUS questionnaire	~10 minutes	Component 3

The total of approximately 100 minutes was expected to participate in components 1, 2, and 3 of the study.

3.4 Study Design and RQs

To connect the study design with the RQs, the RQs presented in (2.6) are further detailed in this section. The following RQs are addressed by component 1 of the study.

Broad RQ1: Will the use of the KWM improve vocabulary learning outcomes?

RQ1.1: Will the use of the KWM improve vocabulary learning in the app setting?

RQ1.2: Will the use of the KWM improve vocabulary learning in the P&P setting?

The above RQs are addressed by the analysis of collected data for comparing word-set 1 vocabulary backward and forward recall of control and experimental groups in app and P&P settings.

Broad RQ2: Will different KWM instruction methods affect vocabulary learning with KWM in different experimental groups?

RQ2.1: Will different KWM instruction methods (encoding vs encoding and retrieval) affect bidirectional vocabulary learning with KWM in the app setting?

RQ2.2: Will different KWM instruction methods (encoding vs encoding and retrieval) affect bidirectional vocabulary learning with KWM in the P&P setting?

The above RQs are addressed by the analysis of collected data for comparing word-set 1 vocabulary backward and forward recall of experimental (encoding vs encoding and retrieval) groups in app and P&P settings.

Broad RQ3: Will the KWM affect vocabulary learning short-term and long-term recall?

RQ3.1: Will the KWM affect vocabulary learning short-term and long-term recall in the app setting?

RQ3.2: Will the KWM affect vocabulary learning short-term and long-term recall in the P&P setting?

RQ3.3: Will different KWM instructions (encoding vs encoding and retrieval) affect bidirectional vocabulary short-term and long-term recall in the app setting?

RQ3.4: Will different KWM instructions (encoding vs encoding and retrieval) affect bidirectional vocabulary short-term and long-term recall in the P&P setting?

The above RQs are addressed by the analysis of collected data for comparing word-set 1 vocabulary backward and forward recall of control and experimental (encoding vs encoding and retrieval) groups in app and P&P settings in occasions 1, 2, 3, and 4.

Component 2 of the study (as an independent study) had the following RQs based on the results in component 1 of the study as the same participants were engaged in component 2 of the study.

Broad RQ4: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions)?

> **RQ4.1:** Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions) in the app setting?
>
> **RQ4.2**: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions) in the P&P setting?
>
> **RQ4.3**: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions) over time in the app setting?
>
> **RQ4.4**: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions) over time in the P&P setting?

The above RQs are addressed by the analysis of collected data for comparing word-set 1 and 2 vocabulary backward and forward recall of control and experimental (encoding vs encoding and retrieval) groups in app and P&P settings in occasions 1, 2, 3, and 4.

The following question is the broad RQ for component 3 of the study.

Broad RQ5: Is the designed web application for this study usable?

> **RQ5.1**: Is the designed vocabulary learning web application useable and learnable from user interface (UI), user experience (UX), and user interactivity design perspectives?
>
> **RQ5.2**: What are the UI, UX, and user interactivity issues and strong points of the designed web application?

RQ5.3: What is the acceptance rate of the designed web application?

RQ5.4: Are there significant differences in the usability of the designed web application for different experimental/control groups?

RQ5.5: What effects do guided and unguided tasks designs have on the usability test results and relation between them?

The above RQs are addressed by the analysis of collected data for comparing the SUS scores of control and experimental groups in app setting.

Regarding RQ5.5, both guided and unguided tasks designs were independent to each other. In common, they have the same set of tasks and number of participants but differ with respect to different groups of participants. In guided tasks, users will perform the tasks with guidelines. The following scenario gives an overview of a guided task (this was included in the web application by the nature of the KWM instruction)

a) task: learning words on the web application (experimental groups)
b) guidelines
    i. as presented in Table 9, some example words were shown with instruction on encoding or encoding and retrieval trainings and
    ii. when the user is on the web application, they know what to expect (e.g., the steps in learning word, keyword, meaning, encoding, and so forth).

In unguided tasks, users were left to determine how they would learn the words without instruction from the web application or the experimenter. For the above task, the unguided task scenario is as follows

a) user will be in the web application learning the words on their own.

3.5 Materials and Tools

This section presents the material and tools utilised in the current study.

Consent form, information sheets, letter of introduction, recruitment email, background questionnaire, and list of word-pairs were all in Persian (available at Appendix (I), Appendix (II), Appendix (III), Appendix (IV), Appendix (V), and Appendix (IX),

respectively). However, the English translated/annotated versions are utilised in the current section for demonstration purposes.

In the present study, as previously mentioned, in selection of words and keywords for the KWM training, word-sets 1 and 2, concrete high-vividness words along with experimenter-generated keywords were used. The length, syllables, and types of the words were also controlled.

Sections 3.5.1 and 3.5.2 present the material and tools for P&P and app groups, respectively.

3.5.1 Pen and Paper

For P&P groups, three booklets (in Persian) were designed; one to show a demonstration of required tasks with/without the KWM strategy training (with: KWM training for experimental groups, without: for control groups), one to teach the words, and one to test word recall via a bidirectional recall questionnaire. The syllable and part of speech for all the selected words were similar (2–3 syllable concrete meanings nouns). To suit both KWM explicit instruction and vocabulary learning and testing requirements, the KWM training, the learning, and testing booklets were separated based on the studies of Mirzaei et al. (2018) and Wyra et al. (2007).

3.5.1.1 KWM Training Booklet

The demonstration (strategy) training booklet (phase 1 of Table 9) was concerned with teaching the participants how to use the KWM. Explicit instructions, examples, modelling, and independent learning practice were used to facilitate the learning of the KWM strategy and its use. Specifically, the strategy training (either encoding or encoding and retrieval instructions) had explicit instructions, examples, modelling, practice, and applying/learning followed by distraction, testing, and evaluation (Wyra et al., 2007). The strategy training booklet was adopted from Wyra's studies (Wyra et al., 2007; Wyra & Lawson, 2018). The booklet was presented to students in Persian; however, for demonstration purposes Wyra's training booklet pages designed for speakers of English are shown in Figures 10 and 11. The booklet translated to Persian and used in this study is available in Appendix (VII).

LEARNING NEW WORDS

A. INTRODUCTION

Follow along with me as we go through the handout.

We are developing methods that will help students memorise and recall the meaning of new words so that those meanings will stay in their memory.

The **keyword method** is designed to make learning and recalling meanings of new words more systematic. It's designed to give you a way to **"anchor"** new information to what you already know and to help you to recall that information later on. Basically, it's **designed to set up new links** to your existing knowledge, so that these links can be used when you want to retrieve or get a meaning from your memory.

B. THE KEYWORD METHOD

Let's say we want to learn the meaning of the word: **SUAMI**.
You look it up in the dictionary and see that it means ***husband***.

Indonesian word: ***suami***
meaning: **husband**

Now here is where you do something different.
You don't stop after reading the dictionary definition. **You use the keyword method to make links between the new word and its meaning.**

It is these new links that help get the word into your memory.

The keyword method involves **2 steps**.
The first step is called the **sounds like and looks like** step,
the second is the **picture** step.

STEP 1: SOUNDS LIKE  **and LOOKS LIKE** 

The **first step** in learning your new word is to try to get another word that **sounds like** and probably **looks like** some part of the new Indonesian word suami. This will usually be an English word you know well. It could also be a word from another language.

This word needs to have a **concrete meaning**; that is, a word that stands for something that **you can see and touch.**

This word that sounds like part of the new word is called the **KEYWORD**

It is called the KEY-word because it's the key to recall. This keyword is the key that will enable you to recall the meaning of the new Indonesian word.

Let's try this with SUAMI.
First we look for an English word that **sounds like, and/or looks like**, some part of the new word. Well, SUAMI sounds like the English word TSUNAMI.

TSUNAMI is a good concrete word: a tsunami is something **you can see**.
So let's make TSUNAMI our keyword.

new Indonesian word	= *suami*
the meaning	= *husband*
keyword	= *tsunami*

STEP 2: DEVELOP A PICTURE.
The second step - the picture step - involves the development of an image in your mind (a mental picture). This picture can be a still picture, like in a picture book or a photograph, or it can be running like a video clip or a gif which you design.

Now the important thing to do in this picture is to make sure that **the picture links the meaning and the keyword** in a **memorable or unusual way**, so that when you look at the keyword, the meaning will also come to mind.

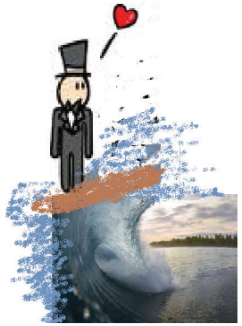
PICTURE = MEANING + KEYWORD

We'll try this out for *suami*.

the meaning is *husband*
the keyword is *tsunami*
so make a picture linking a *husband* and a *tsunami*, so that when we think of a *tsunami* we also see a *husband*.

PICTURE = MEANING + KEYWORD
PICTURE = HUSBAND + TSUNAMI

You might have:
- a husband surfing on a tsunami.



Any other ideas?

Figure 10. KWM training booklet pages 1-2 (Wyra et al., 2007; Wyra & Lawson, 2018)

D. RECALLING THE MEANING AT A LATER TIME.

So far we've talked about ways to help us **learn** the meanings of new words. That is, we've worked on some new ways to get the word meanings **into our memories.** But getting the word and the meaning into the memory is only half of the new system.

We also want to use the new system to help **recall** (bring to mind, call to mind) that meaning at a later time, and the keyword procedure can be used in reverse to help us **get the meaning out of the memory.**

The keyword method can also be used to help us recall the meaning of the word. So, how can you use the keyword method to recall the meaning of a previously unfamiliar word?

You do the following:

1. Look carefully at the word. Have you seen this word before?
2. Yes. Did you use the keyword method on this word?
3. If you think you have used the keyword method on this word, what was your keyword?
4. Now search your memory for a picture that has links with your keyword.
5. Inspect the picture carefully and look for the unusual or vivid thing in the picture.
6. This will usually suggest the meaning of the word.

Let's try this out with words you have learned.

You come across the word ***suami*** and want to recall its meaning. So use the keyword steps:

- ✓ Look for the keyword in ***suami.***
- ✓ Use the keyword to search your memory for a picture.
- ✓ Search the picture for something unusual.

And so:

- ✓ The first part looks like the word ***tsunami.***
- ✓ Have you got the picture of a ***tsunami***? Yes.
- ✓ What is it that is unusual about this picture? **What really stands out?**
- ✓ There's a huge husband trying to surf a tiny tsunami.

- ✓ The word ***suami*** means ***husband.***

Recalling the Indonesian word

Now you know how to recall the meaning of a new Indonesian word that you have learnt using the keyword method.

But how will you recall the Indonesian word when you see the English word?
You do the following:

1. Look carefully at the word. Search your memory for the funny, unusual pictures with the image representing this word.
2. Do you see a funny picture with two images that include an image of this word?
3. Inspect the picture carefully. What is the second image?
4. This second image is your key to finding the Indonesian word. This second image represents the keyword that you have used in learning.
5. Using this keyword, try to reconstruct the Indonesian word; it sounds or looks like the keyword.

Let's try this out with words you have learned.
You come across the word ***husband*** and want to recall how to say it in Indonesian. So use the keyword steps:

- ✓ Look in your mind for the unusual, funny or bizarre pictures of a husband.
- ✓ Look for the pictures that only have two images.
- ✓ Look at the second image, not the husband.
- ✓ This is your keyword.
- ✓ Reconstruct the Indonesian word for husband using this keyword. You know that the keyword looks or sounds like the Indonesian word you are looking for.

And so:

- ✓ Have you got an unusual picture of a husband? Yes.
- ✓ You found a picture of a huge husband trying to surf a tiny tsunami.
- ✓ What is it that is unusual about this picture? **What really stands out?** There's a ***huge husband trying to surf a tiny tsunami***.
- ✓ The word ***tsunami is your keyword.***
- ✓ Now you search your memory for the Indonesian word that looks or sounds like ***tsunami.***
- ✓ ***SUAMI.***

So remember. Use the keyword method:

- **to get meaning into your memory**
- **to get meaning out of your memory**

THESE TWO USES ARE SHOWN IN THE DIAGRAM

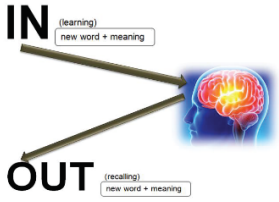


Figure 11. KWM training booklet pages 3-4 (Wyra et al., 2007; Wyra & Lawson, 2018)

3.5.1.2 Word Learning Booklet

In the word learning booklet, for each word to learn, the corresponding Persian translation and the keyword were presented on a separate page (22 word-pairs – 22 separate pages). Participants had 20 seconds to look at each page with an aim to learn while the participants were asked to keep track of the time to spend on learning each word to equate the read time for each condition. An English translated version the learning booklet is shown in Figure 12. The actual Persian booklet is available in Appendix (VII).

English word	Persian meaning	Keyword
gambol	جست و خیز	گامبو

Please do not turn the page until you are asked to do so!

Figure 12. Word learning booklet

3.5.1.3 Vocabulary Tests

The P&P groups test sheet used for each vocabulary testing occasion was based on the format designed by Wyra et al. (2007) to capture a bidirectional vocabulary recall performance; that is, forward recall for 11 words where English words were provided and participants needed to provide their Persian equivalents, and backward recall for 11 words where Persian words were provided and participants needed to provide their English equivalents. Figure 13 shows the English translated version of test sheet used in this study (the actual Persian version is available in Appendix (VII).

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شناسه
G1 -

Listed below are Persian words and their meanings you learned using the keyword method. Please write down the corresponding English meaning of the Persian word or the Persian word corresponding to its English meaning in the provided column. If you are not absolutely sure of the meaning for a particular word, but you think you have a good chance of being correct, write down what you think.

Only leave blanks when you have no idea. Use the third column to write anything that you remember in relation to the word that you can't recall or if you are not sure.

Persian words	Meaning	Anything you remember
mortal		
quarter		
verse		
morality		
clergy		
idol		
charity		
lunatic		
vein		
fertility		
loyalty		
	برگه رای	
	لال	
	بسته	
	نوجوان	
	کسوف	
	جراحی	
	افسانه	
	پشم	
	سردخانه	
	طعمه	
	اشتباه	

Figure 13. P&P vocabulary test sheet

3.5.1.4 Distracting Activity

In order to take participants' attention away from the newly learnt word-pairs between the learning and testing phases of this research, as in Mirzaei et al. (2018) and Wyra et al. (2007) studies, distraction activities were provided (as presented in Table 9). The participants in the P&P groups were engaged in a casual conversation not related to the learning task to serve this purpose. This distraction took three minutes.

3.5.2 App

For app groups, a web application was required to facilitate vocabulary learning and testing via the KWM. Accordingly, the KWM training (exactly the same as in the P&P) was embedded in this web application. This was followed up with timed word-pair and keyword presentation of the 22 English-Persian word-pairs with keywords (for the KWM experimental groups) and without the keywords for the control KWM group. Then, the test page (exactly the same as in the P&P) was embedded in the web application.

For the purposes of this research for this thesis only desktop PCs and laptops were used; that is, the web application was not used on other devices such as phones or tablets. The main reasons for this choice were study environment limitations, device availability, control over environment, hardware, software, screen size issues (consistency between experiences), and security issues (in case of using participant own devices). Therefore, lab provided PCs were a better solution. The web application itself was investigated, its effectiveness and its usability. The web application can be used in a mobile device as well as on a PC. The tool/hardware is not of interest in this study hence the change from the intended mobile device use to the PC use is not an issue of concern. However, being a web-based application with responsiveness considerations, the designed web application for this research study is operable on different platforms for future and follow-up research possibilities.

In the following sub sections, first, the utilised technology and programming languages are discussed. Then, tutorial and demonstration, word learning, test and distracting activity pages along with the SUS questionnaire are presented.

3.5.2.1 The Utilised Technologies

Web applications are software packages accessed via web browsers. Liu and Xu (2001) considered web applications as an essential technology for enhancing productivity and efficiency in organisations.

Web applications are utilised in academic and business environments to provide anytime, anywhere access to information in the world while saving resources and improving interactivity with users.

One major model of web application development is three-tier architecture (Hu et al., 2003). As shown in Figure 14, three-tier web-based system architectures are client-server architectures utilised mainly in Internet-based web applications while having independent modules on separate platforms for functional process logic, data access, data storage, and user interface (Ramirez, 2000). There are three tiers of the presentation (user interface), application, and data (or database) (presented in Figure 14). In this model, the clients send requests to the centralised server(s) and receive service from servers while the returned request results are shown on the client's user interface. For instance, the World Wide Web (WWW) uses the three-tier architecture in which clients are PCs (accessing the Internet via the web browsers on them) and servers are remote machines.

Figure 14 shows the required procedures a client should go through for requesting information from web servers. This is facilitated through a middleware (sever) to connect to a database to obtain the information required to respond to the client or clients' request(s). In the database, a database management system (DBMS) takes care of creating, editing, deleting, and maintaining a database or collection of data records to facilitate the information needs.

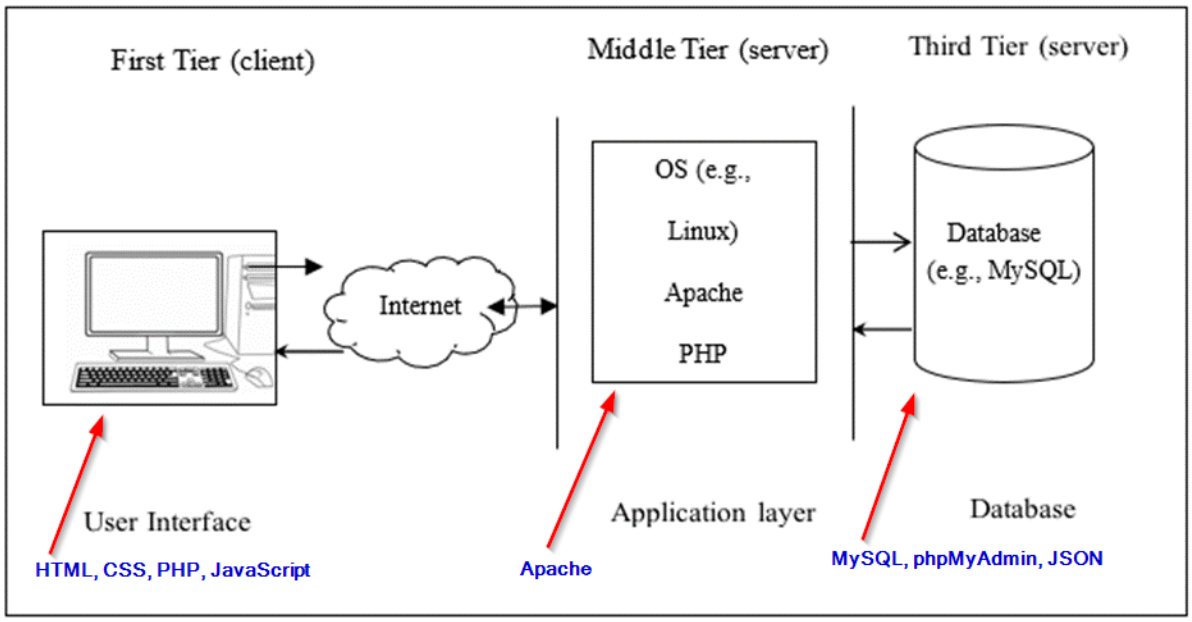


Figure 14. Three-tier web application architecture (modified from Ramirez (2000))

A number of programming languages and technologies were utilised in the development of the web application used for the current research study. The software side (the programming languages and technologies) included HTML, Cascading Style Sheets (CSS), Hypertext Pre-Processor (PHP), JavaScript, Apache, MySQL, JavaScript Object Notation (JSON), and phpMyAdmin and the hardware side of it was computer devices (accessing the web application via a browser). The JetBrains PhpStorm integrated development environment (IDE) was used for the coding required for the web application. JetBrains PhpStorm IDE was chosen because of its many features such as its smart PHP code editor, code quality analysis features, easy code navigation and search functions, debugging, testing and profiling features, and supporting all of the required programming languages for the current study (list of features available in https://www.jetbrains.com/phpstorm/features/) (PhpStorm: The Lightning-Smart IDE for PHP Programming by JetBrains, 2020).

3.5.2.2 Utilised Scripting/Programming Languages

In this section, the utilised programming languages are discussed as the used technologies in this research study are already covered in section 3.5.2.1.

HTML and CSS are two of the core programming languages used in web technologies for building web pages; “HTML provides the structure of the page, and CSS the (visual and aural) layout, for a variety of devices” (HTML & CSS. W3C Official Website, 2020).

Defined as a scripting or programming language, JavaScript allows complex implementation of a web page features by displaying more than just static information to look at every time a web page is loaded. JavaScript is involved when a web page displays “timely content updates, interactive maps, animated 2D/3D graphics, scrolling video jukeboxes, etc.” (What Is JavaScript. MDN Web Docs, 2020). In the current study, JavaScript was mainly used to facilitate the use of the interactive distraction game designed within the web application.

PHP is a server-side scripting programming language used for web development. PHP was invented by Rasmus Lerdorf in 1994 as a one-person project (Lerdorf et al., 2006). PHP is used for handling information in a database to generate dynamic and interactive web pages while its code is interpreted at the web server and generates HTML or other outputs (Welling & Thomson, 2003). For the present research study, PHP version 7.1.30 was used on the server side of the web application in JetBrains PhpStorm IDE.

Web development technologies used in the current study including Apache version 2.4.39, MySQL, JSON version 2.0.1, and phpMyAdmin version 4.9.0.1 were operating via XAMPP version 7.1.30-0. In XAMPP acronym, X stands for cross-platform while the rest of the letters are for **A**pache, **M**ySQL, **P**HP, and **P**erl, respectively. XAMPP is a light cross-platform Apache distribution, which contains a number of web development technologies in one single package (Dvorski, 2007). Apache, which is the most widely used web server platform, is a web server for Unix, Windows, and other operating systems (Laurie & Laurie, 2002). MySQL is a cross-platform open-source relational database management system (RDBMS) created by Michael Widenius in 1995 under the GNU General Public License. SQL stands for Structured Query Language – the language used to handle queries and databased in RDBMS. In the present study, MySQL sever was used in XAMPP to facilitate use of databases along with JSON and phpMyAdmin to store the require data. JSON is a human-readable data interchange technology and is in a text format. JSON is not only easy for humans to read and write but also easy for machines to parse and generate (*Introducing JSON. JSON Official Website*, 2020). phpMyAdmin, which is a free cross-platform open-source MySQL administration tool, was first released in 1998 under the

GNU General Public License (About phpMyAdmin. phpMyAdmin Official Website, 2018).

To summarise the programming languages and technologies utilised in the present study, an Apache server within XAMPP was used along the PHP language to run the server side of the designed web application, MySQL was the open-source database, and phpMyAdmin was used to work with the databases. More specifically, in this research study, the PHP code, while facilitating the web development on the server side and operating along HTML, CSS, and JavaScript, opened the connection to a MySQL server and took care of the execution of various queries to retrieve data from and save data to the databases in phpMyAdmin. Supporting MySQL features in a web interface (About phpMyAdmin. phpMyAdmin Official Website, 2018), phpMyAdmin was utilised via XAMPP to handle the database and JSON files required for the designed web application. As stated by the JSON (2020) official website, there are two data structures of object and array in a JSON file. The object is an unordered set of name/value pairs beginning and ending left '{' and right '}' braces, respectively, while separating each name by a colon ':' and separating name/value pairs by a comma ','. The array is an ordered list of values starting and ending with left '[' and right ']' brackets, respectively, while separating values by a comma ','. JSON files were saved in phpMyAdmin databases in the designed web application to save the results of answers (vocabulary recall test results) in the web application. A screenshot of phpMyAdmin is shown in Figure 15.

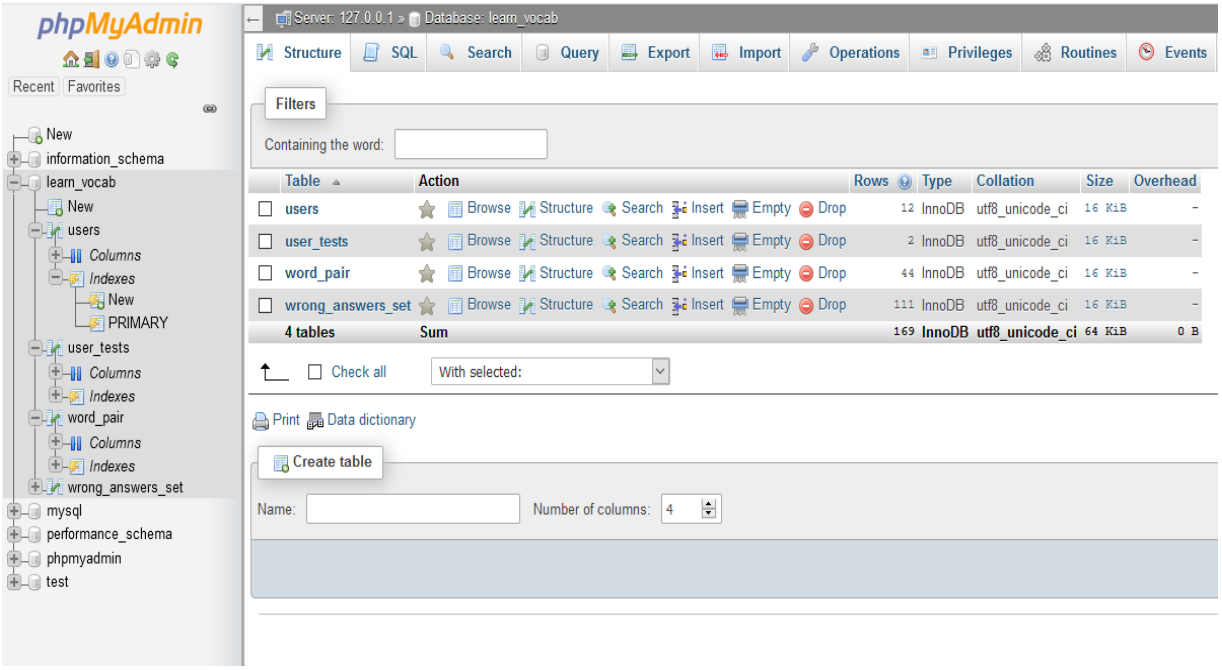


Figure 15. PhpMyAdmin screenshot

As presented in Figure 15, the phpMyAdmin dashboard had a number of tools to cover required RDBMS functionalities and queries. The Entity Relationship Diagram (ERD) logical modelling for the database is shown is Appendix (X).

As this web application was designed for native Persian speakers, all parts of the web application were in the Persian language.

The developed web application was designed and developed to be engaging. Technology increases learners' engagement and interaction. Derakhshan and Khodabakhshzadeh (2011) outlined how computer-assisted vocabulary learning helps learners in all learning process stages of:

a) engagement (by engaging reluctant learners via device originality and allure of audio/visual material),
b) assessment (via making assessment less intimidating than traditional paper-based versions while being more private and independent),
c) teaching (through utilising innovative and emerging technologies that help learners with easier understanding of the concepts), and

d) practice (by providing the learner with an opportunity to practice anytime, anywhere via accessibility features of CALL/MALL devices).

For the present research study, the prototype web application was developed via the programming languages and technologies discussed in sections 3.5.2.1 and 3.5.2.2 and considering the prototyping rationale discussed in section 2.5.2. This web application facilitated the purpose of the research study – teaching the KWM, using it for learning new words, and testing learners' recall. The tutorial (KWM training) and demonstration videos were embedded in the web application to learn the KWM and the know-how of using the web application, respectively. The tutorial and demonstration videos were shown to the participants only once on their first interaction with the web application. The web application had four sections of

1. sign-up/authentication,
2. vocabulary learning,
3. the distraction game, and
4. vocabulary testing.

The vocabulary testing section was used for collecting the data that was required for the statistical hypothesis testing to answer the RQs regarding recall of learnt words.

The web application start screen contained the name of the web application, along with the researcher's and supervisors' details, Flinders University logo, and the login and sign-up buttons. To be able to access the tutorial and demonstration pages, the users needed to be logged in first. After logging in the first time, on the welcome page, if clicking on the tutorial or demonstration buttons, the user would be directed to the tutorial or demonstration pages which included the training videos. The tutorial and demonstration pages had the same design but were showing different videos. This was mainly because the control and experimental groups were given different videos for tutorials and demonstrations (two different variations of KWM instruction videos for the tutorial button and one web application (know-how) demonstration video button for the experimental participant group (for the KWM encoding vs encoding and retrieval groups) and only one web application demonstration video for the control group). Figure 16 shows the start screen, sign-up, and welcome pages (left to right order).

Figure 17 presents the tutorial and demonstration selection and tutorial video pages (left to right order).

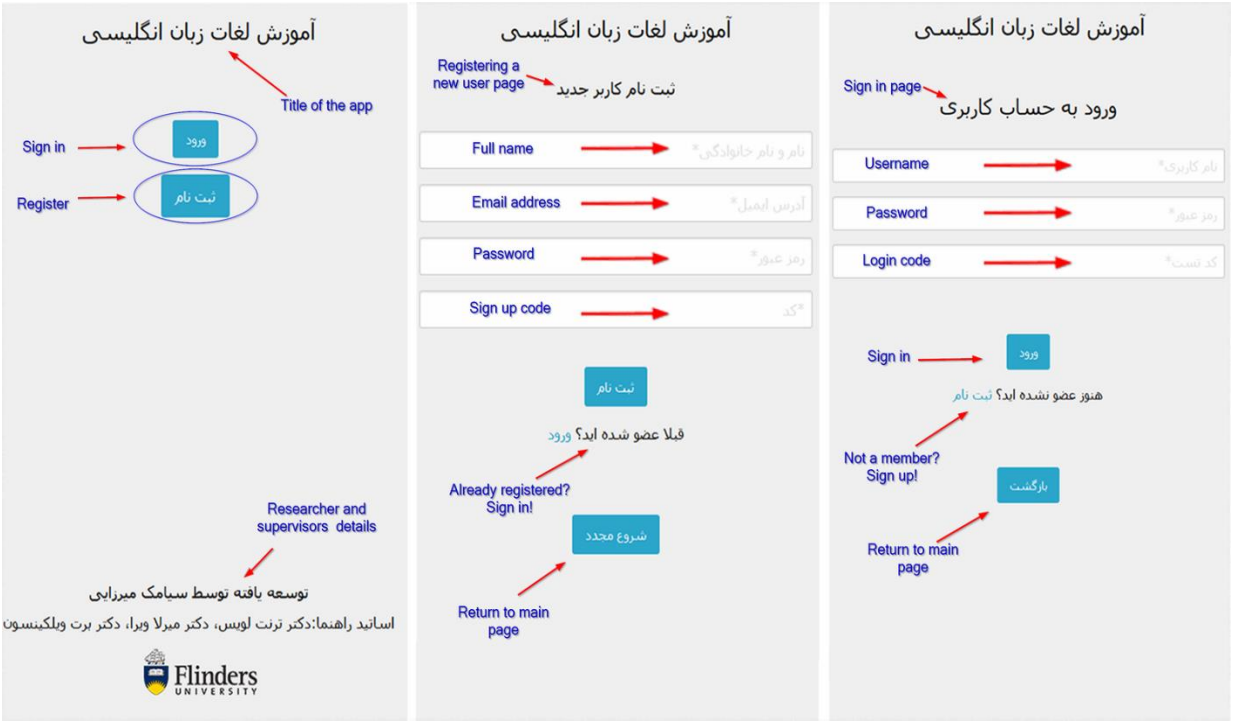


Figure 16. Start screen, sign-up, and login pages (left to right)

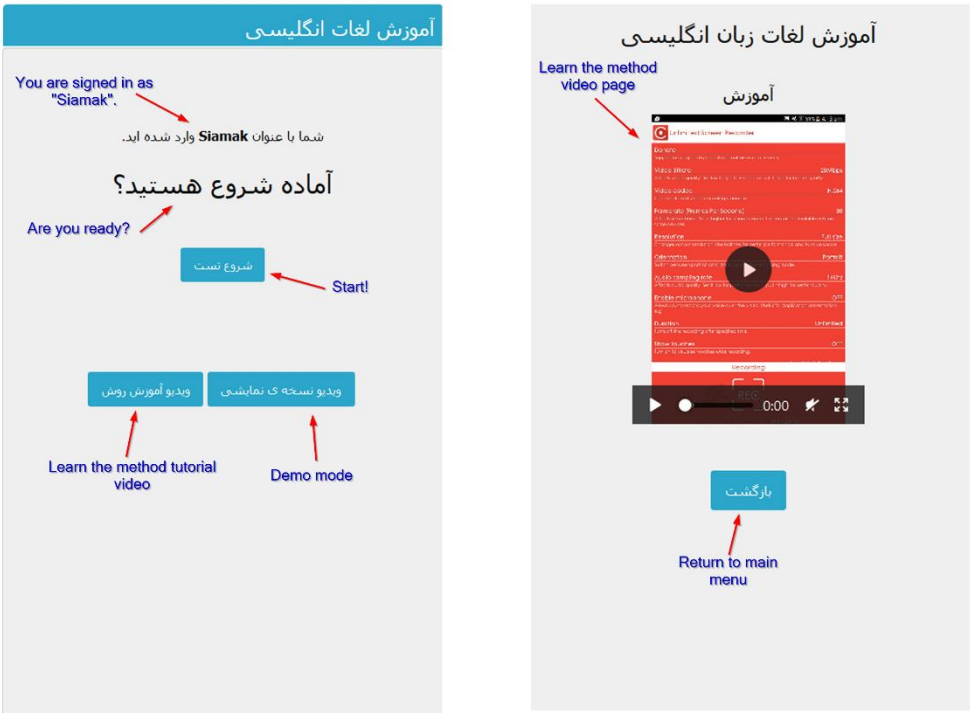


Figure 17. Tutorial and demonstration selection and tutorial video pages (left to right)

As discussed in section 2.5, the FRAME model affected the web application design choices with (DL) considerations (e.g., web application for anywhere anytime information access), (DS) considerations (e.g., via the internet through the web application), (LS) considerations (e.g., signs, symbols, and behaviours in the web application), and (DLS) considerations as the key intersection and the meeting point of the discussed aspects (DL, DS, LS) to achieve the overall targeted learning tasks and web application design to encourage active participation of the learners. Similarly, memory-based strategic model for vocabulary learning model and framework for technology-mediated L2 lexical applications learning and explicit strategy instruction recommendation by Ma (2013, 2014, 2017) aimed to guide the web application design within the dedicated lexical applications category to provide learners with initial learning contexts (e.g., the KWM training and examples) and subsequent rehearsal (i.e., several recall occasions) to encourage best practices and strategy learning as suggested by Ma (2017).

The web domain used for hosting the web application was Secure Socket Layer (SSL) certified (HTTPS) as participants' details (including their names and email addresses) were to be sent to a webserver (securely). The sign-up page had three fields for username (email), password, and an experiment sign-up code (Table 11). The login page had fields for full name, email address, password, and a login code (Table 12) to correspond to the participants' accessible web application sections based on their randomly allocated experiment group. The participants' passwords were hashed and encrypted via phpMyAdmin capabilities. The experiment sign-up and login codes were provided to the participants by the researcher.

The experiment login codes corresponded to the different sections of the experiment based on the experiment design. The sign-up, login, tutorial, and demonstration pages had navigation buttons to go back to the start screen if required. The list of experiment group (sign-up) and experiment phase (login) codes are shown in Tables 11 and 12.

Table 11. Sign-up codes and corresponding experiment groups

Sign-up Codes	Corresponding Experiment Groups	Usage Examples
'ctrl'	Control (represented by 'ctrl (app)' in experimental study design in Table 9)	The participant belonged to the control app group. The control app group's specific demonstration video was shown after logging in for the first time and clicking on the relevant buttons per the study design (Table 9).
'exret'	Experimental retrieval (represented by 'KWM - ret (App)' in experimental study design in Table 9)	The participant belonged to the experimental retrieval app group. The experimental retrieval app group's specific demonstration and tutorial videos were shown after logging in for the first time and clicking on the relevant buttons per the study design (Table 9).
'exenc'	Experimental encoding (represented by 'KWM - enc (App)' in experimental study design in Table 9)	The participant belonged to the experimental encoding app group. The experimental encoding app group's specific demonstration and tutorial videos were shown after logging in for the first time and clicking on the relevant buttons per the study design (Table 9).

As shown in Table 11, only particular sections of the web application were available to different participant groups. Accordingly, the sign-up codes were used in the web application back end to enforce the study requirements since some web application features were different for control and experimental groups. For instance, in the vocabulary learning section of the web application, the keyword was only shown to the experimental group participants.

Table 12. Login codes and accessible web application sections

Login Codes	Accessible Web Application Sections	Reasons to Have the Codes
1LWS1	Learning of word-set 1	The user could only learn the words once.
1TWS1	First occasion of testing word-set 1	The user could only take the test on the learned words right after learning 1LWS1.
2TWS1	Second occasion of testing word-set 1	This section was only accessible after the requirements for the second occasion of testing word-sets 1 were met (**Error! Reference source not found.**).
3TWS1	Third occasion of testing word-set 1	This section was only accessible after the requirements for the third occasion of testing word-sets 1 were met (**Error! Reference source not found.**).
4TWS1	Fourth occasion of testing word-set 2	This section was only accessible after the requirements for the fourth occasion of testing word-sets 1 were met (**Error! Reference source not found.**).
1LWS2	Learning of word-set 2	The user could only learn the words once. Also, the requirements for 1LWS1, 1TWS1, 2TWS1, 3TWS1, and 4TWS1 should have already been met before this stage (**Error! Reference source not found.**).
1TWS2	First occasion of testing word-set 2	The user could only take the test on the learned words right after 1LWS2.

Login Codes	Accessible Web Application Sections	Reasons to Have the Codes
2TWS2	Second occasion of testing word-set 2	This section was only accessible after the requirements for the second occasion of testing word-sets 2 were met (**Error! Reference source not found.**).
3TWS2	Third occasion of testing word-set 2	This section was only accessible after the requirements for the third occasion of testing word-sets 2 were met (**Error! Reference source not found.**).
4TWS2	Forth occasion of testing word-set 2	This section was only accessible after the requirements for the fourth occasion of testing word-sets 2 were met (**Error! Reference source not found.**).

The login codes presented in Table 12 were used in the web application back end to enforce the study requirements; for instance, participants were not able to login twice to re-do the tests.

Error! Reference source not found. shows a simple presentation of login codes and a ccessible web application sections in a flow chart for better understanding.

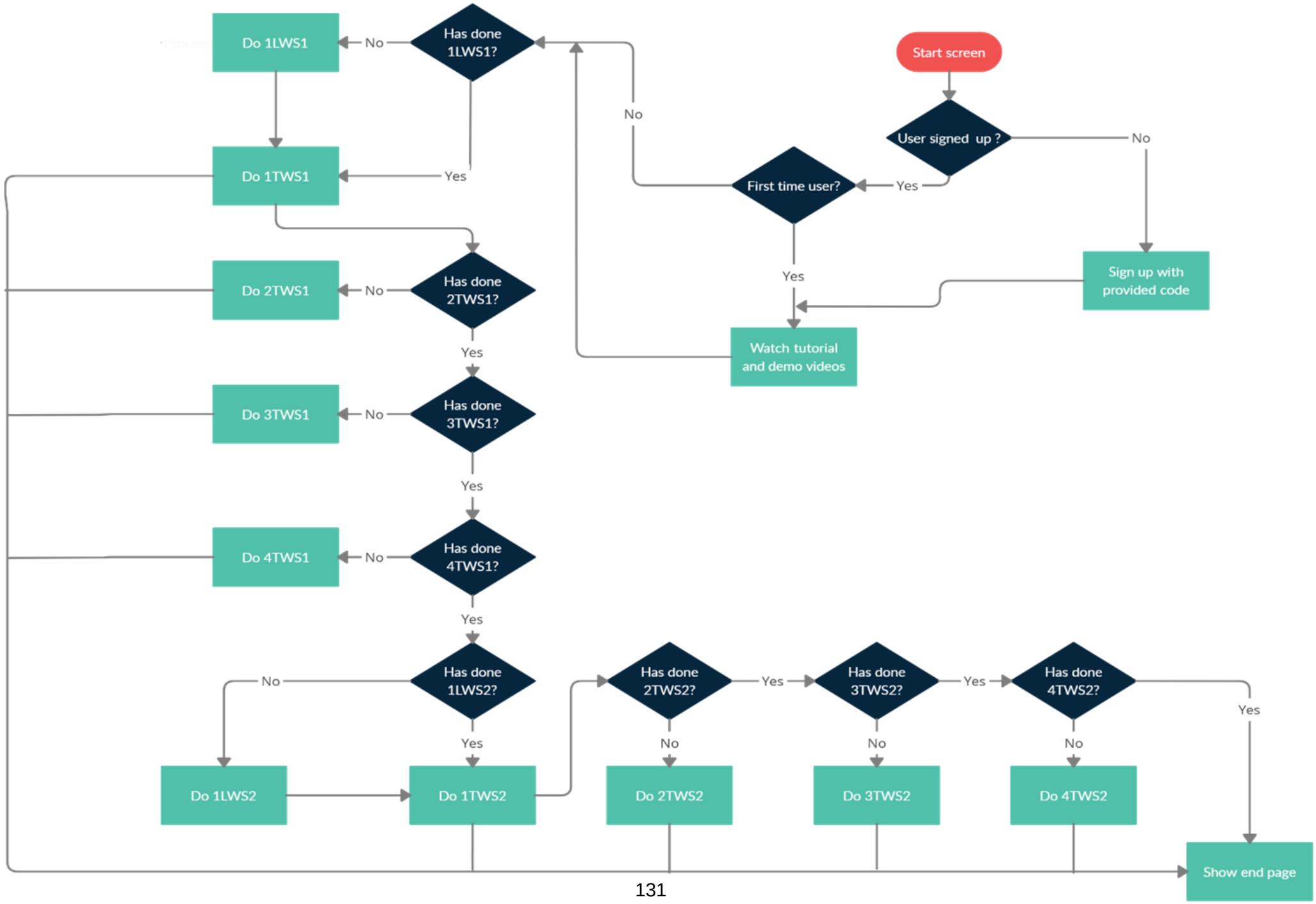


Figure 18. Flowchart presentation of login codes and accessible web application sections

As shown in **Error! Reference source not found.**, after the start screen and returning from t he demonstration and/or tutorial pages, the user could click on the 'start' button to start the first part of the web application, that was, the section to teach the words. As elicited from Tables 11 and 12, the tutorial and demonstration videos were shown based on the experimental study design for component 1 of the study participants only (Table 9). It was also possible to visit the tutorial and demonstration pages only once. The sequence of the web application was per study's experimental study design (Table 9) and as presented in Table 12.

In the learning section of the web application, for all three control and experimental groups, there were two word-sets of 22 word-pairs to be taught, so 22 web pages of the same page designs were presented as shown in Figure 19. The order of the word-pairs shown to all three control and experimental groups was the same in word teaching (learning) and testing pages of the web application per the study design (Table 9).

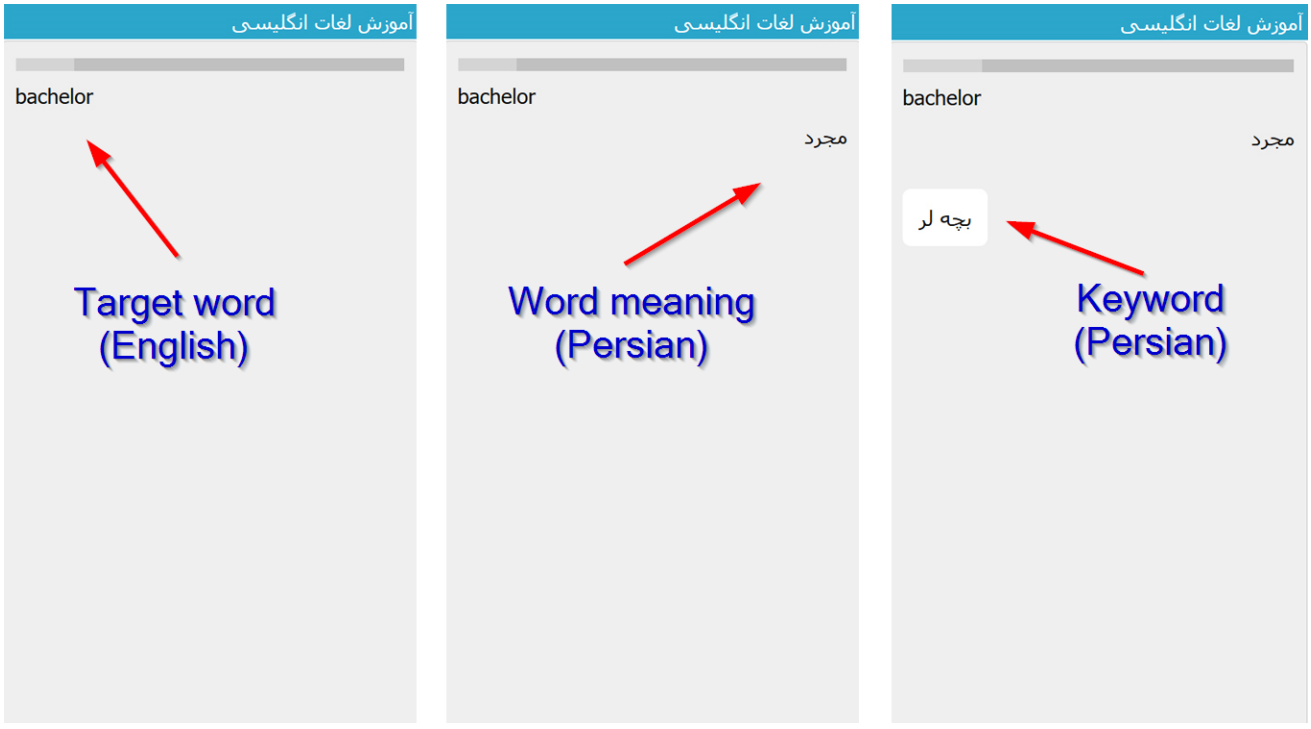


Figure 19. Different steps of teaching a word in the web application

All the similar web pages in the teaching section (Figure 19) had the following three steps

1. In step one, the 'Target word' to be taught was shown for one second as presented in Figure 19 (left).
2. Step two was to show 'Word meaning' (in Persian) after two second from when the screen loaded as presented in Figure 19 (middle).

3. Last step (step three) was showing the 'Keyword' (in Persian) and highlighting it (acoustic similarity) after 5 seconds from when the screen loaded as presented in Figure 19 (right).

Steps one to three were mapping the previously mentioned association of the KWM (associating the foreign to-be-learned word to the keyword, which has a similar pronunciation (acoustic link), as discussed in section 2.1.3.2). As mentioned previously, Wyra et al. (2007) used orthographic links to connect the new to-be-learned word with the keyword; however, as Persian language has no orthographical similarities with English, Persian keywords with acoustic links to the English target words were selected to be utilised in this section of the web application (section 2.1.3.1). Based on the provided video training in the strategy tutorial, the rest of the available 15 seconds time (indicated by the dynamic timer on top of the screen) was used by the learners to create the mental image while the target word, word meaning, and the keyword were still shown on the screen. This was to correspond to the elaboration step of the KWM (creating a mental image of the keyword interacting with the word meaning of the target FL word). The step for showing the keyword (step three) was only available and applicable to the KWM experimental groups (not the control group) (Table 9).

The graphical dynamic countdown time was shown at the top of the screen in a neutral colour to remove the potential for any possible stress. After reaching the end of the timer, the next word would show up automatically (after 20 seconds from showing the previous target word). The time allocated for learning new word-pairs (20 seconds) was adopted from Wyra et al.'s (2007) study. The algorithm behind this was having a counter starting from 20 to 0, and then scheduling each required action.

All these steps were designed according to methodology and study requirements adopted from Wyra et al. (2007).

After presenting the 22 word-pairs for word-set 1 to be learned (1LWS1), according to the study requirements, participants were distracted (for 3 minutes), in order for them to stop thinking about the strategy (the KWM) and new words before engaging in the testing section of this study (1TWS1). For this purpose, as discussed in section 3.5.2.6 in detail and shown in Figure 20, the distraction game was utilised.

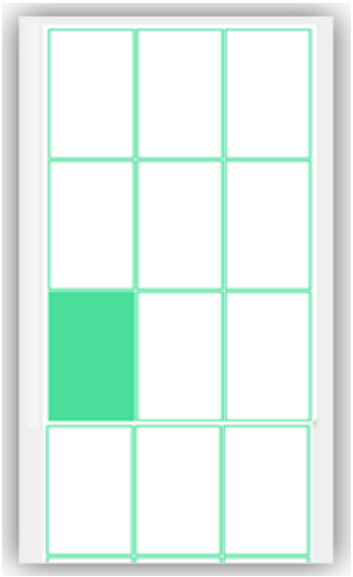


Figure 20. The distraction game section of the web application

After this step, a screen was shown to the user to ask them to click ‘Next’ to start testing the taught words. The main reason for this was anticipating the user interaction; the user might have become bored with the distraction game.

The testing phase of the 22 taught word-pairs of word-set 1 (1TWS1) started with showing a ‘fill in the gaps’ bidirectional test. This screen was shown for 5 minutes, and the same timer as the learning section was used to make the users aware of the time left. There were three columns on the test page titled ‘the word’, ‘meaning of the word’, and ‘whatever you remember’ in the participants’ native language (Persian), respectively. After 5 minutes, the answers were saved automatically in a JSON file in the database and the final page, which included a ‘thank you for taking the test’ message and an exit button would appear automatically. Figure 21 shows the test and end pages of the web application.

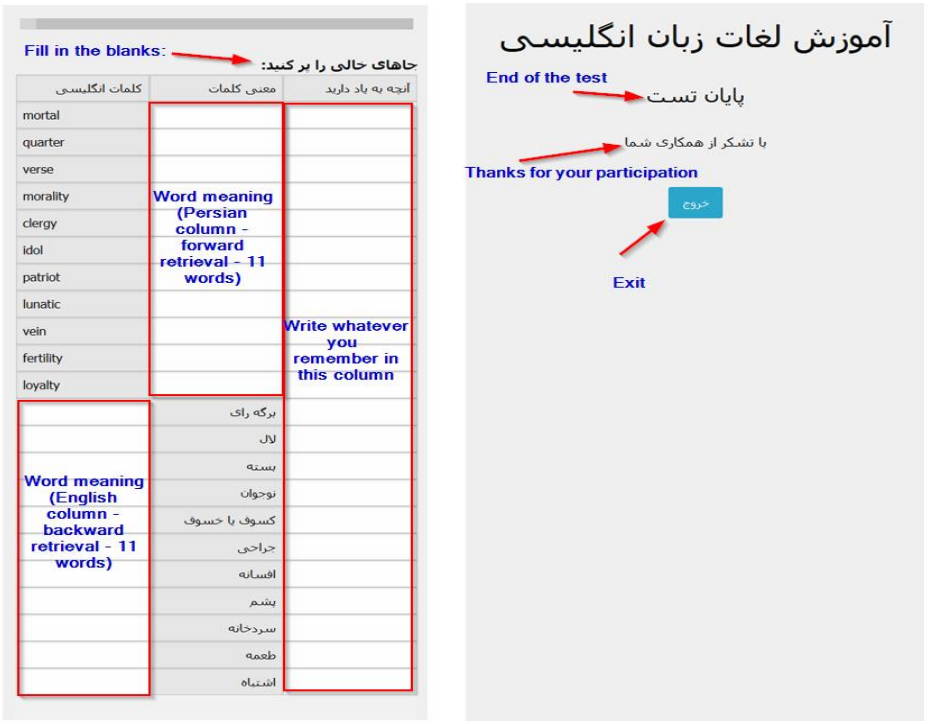


Figure 21. The test (left) and end (right) pages of the web application

The encrypted database was stored remotely on a secure server and phpMyAdmin handled the administration of MySQL over the web.

The below code is an example of a JSON file function to get the recall tests data and save the answers.

JSON Code for Getting the Tests and Saving the Answers to PhpMyAdmin

```
public function get_json_test($db, $test_number) {
    $test_number ="test_ws1";
    $string = file_get_contents("json/".$test_number.".json");
    $json_a = (array)json_decode($string, true);
    $words = $json_a["words"];
    $meaning = $json_a["meaning"];
    return array("w"=>$words,"m"=>$meaning);
}

public function save_json_answer ($db, $test_number, $json,  $user_id,
$answer_duration_time) {
    $timestamp = time();
    $test_date = date('d-m-Y H:i:s', $timestamp);
    $json = addslashes($json);
```

```
    $sql = "insert into  user_tests values (null, $user_id ,
'$test_date','$json', '$test_number', $answer_duration_time )";
    $db->rawQuery($sql);
}
```

The users were not able to go back or reach the test page by refreshing the web page. Cookies and sessions were utilised in the back end of the web application to make this restriction possible. Cookies are small data blocks generated by a web server while a user is accessing a website and are stored by the user's web browser on the user's computer or another device. Cookies which are stored on the devices are used to improve access to a website, and a user's device may receive several cookies throughout a session. Utilising cookies and sessions were challenging tasks as this could cause inconsistencies in the navigation of the web application. The primary use of cookies and sessions is to store sensitive information, such as the user id, safely on the server, away from the reach of unprivileged users (or hackers). However, in this web application, cookies and sessions were used to move data from one page to another and keep track of users' interactions so that proper decisions could be made (as presented in Tables 11 and 12 and **Error! R eference source not found.**).

For the second to fourth (2TWS1, 3TWS1, 4TWS1) occasions of testing of word-set 1, after logging in with the correct details and code according to Tables 11 and 12, the user was only presented with the test and end pages, respectively. A number of customised algorithms and cookies and session features were used to make sure that users cannot reach what is not expected (e.g., doing 3TWS1 before 2TWS1 by entering the wrong code on the login page). In the present study, as stated before, the web application was used for the control and experimental KWM app groups with 40 participants in each group. The control participants were seeing the exact learning and testing sections of the web application with only one difference relevant for the KWM (as displayed in Figure 19); that is, the keywords were not presented to them in the vocabulary learning part of the web application. To accommodate this, as presented in Tables 11 and 12, at the time of signing up to the account for web application access, the control and different experimental groups were given the login and sign-up codes to use them in login and sign-up procedures. Based on these codes, different views were provided to relevant groups in the vocabulary learning section of the web application. The below algorithm presents how this was facilitated in the back end of the web application.

ALGORITHM 1: Authentication Algorithm

```
public function signup($post, $db){
        $emessage = '';
        if(@$post['fullname'] == ''){
            $emessage .= 'Enter your full name!';
        }
        if(@$post['email'] == ''){
            $emessage .= 'Enter your email address!';
        }
        if(@$post['password'] == ''){
            $emessage .= 'Enter your password!';
        }
        if(strtolower(@$post['exp_type']) != 'ctrl' &&
strtolower(@$post['exp_type']) != 'exenc' && strtolower(@$post['exp_type']) !=
'exret'){
            $emessage .= 'Enter the correct code!';
        }
        if($emessage != ''){
            return json_encode(['code' => '400','status' => 'error', 'error' =>
$emessage,'data' => []], JSON_UNESCAPED_UNICODE);
        }else{
            $check_email = $db->where('email',@$post['email'])-
>getValue('users','count(*)');
            $check_error = '';
            if($check_email > 0){
                $check_error .= 'This email already exists!';
                return json_encode(['code' => '401','status' => 'error', 'error'
=> $check_error,'data' => []], JSON_UNESCAPED_UNICODE);
            }
            if($check_error != ''){
                return json_encode(['code' => '400','status' => 'error', 'error'
=> $check_error,'data' => []], JSON_UNESCAPED_UNICODE);
            } else {
                $pass = $this->hashSSHA(@$post['password']);
                $user_id = $db->insert('users',[
                    'email' => @$post['email'],
                    'fullname' => @$post['fullname'],
```

```
                    'password' => $pass['encrypted'],
                    'salt' => $pass['salt'],
                    //assigning forward or forward+backward
                    'exp_type' => strtolower($post['exp_type'])
                    //'start-date' => date('Y-m-j : H:i:s')
                ]);
                return json_encode(['code' => '200','status' => 'success',
'error' => null,'data' => ['user_id' => $user_id]], JSON_UNESCAPED_UNICODE);
            }
        }
    }
```

The same procedures were repeated for learning word-set 2 (1LTWS2) and the four testing occasions of word-set 2 (1TWS2, 2TWS2, 3TWS2, 4TWS2) in component 2 of the study with the only difference that the tutorial and demonstration sections of the web application were not accessible for component 2 of the study to comply with the study requirements.

3.5.2.3 Tutorial and Demonstration Page

The tutorial and demonstration pages (phases 1 and 2 in Table 9) included different videos for control and experimental groups to address the KWM training (tutorial) and web application know-how (demonstration) videos for the experimental groups and a different demonstration video for the control group. Explicit instruction, examples, modelling, and independent learning practice were used to facilitate the learning of the KWM strategy and its use. Specifically, the strategy training (either encoding or encoding and retrieval instructions) had explicit instruction, examples, modelling, practice, and applying/learning followed by distraction, testing, and evaluation (Lawson & Hogben, 1998). The tutorial training page was in Persian; however, for demonstration purposes, a screenshot of the page with English notation is shown in Figure 17 (right). The demonstration video was showing different recorded instructions on how the web application could be used for control and experimental groups.

3.5.2.4 Word Learning Page

In the word learning page, for each word to learn, the corresponding Persian translation and interactive imaginable keyword were presented on a separate page (22 word-pairs – 22 separate pages). The word learning page was in Persian; however, for demonstration purposes a screenshot of the page with English notation is shown in Figure 19.

To have the same procedures as the P&P experimental groups, the 'Target word' to be taught was shown for one second at first as shown in Figure 19, then, 'Word meaning' (in Persian) was shown after two seconds from the time the learning section page loaded. Finally, the 'Keyword' (in Persian) was shown and highlighted after 5 seconds from of the learning section page load time as shown in Figure 19. The countdown timer was shown at the top of the screen. After reaching the end of the timer, the next word would show up automatically (after 20 seconds from the previous target word load time). The time allocated for learning new word-pairs (20 seconds) was adopted from Wyra et al.'s (2007) study.

3.5.2.5 Test Page

The test page included a bidirectional questionnaire with 11 forward (English to Persian) and 11 backward (Persian to English) 'fill the gap' questions, which were asking for Persian and English translations, respectively. The test page was in Persian; however, for demonstration purposes a screenshot of the page with English notation is shown in Figure 21.

The testing phase of the 22 taught word-pairs of word-set 1 started with showing a 'fill the gaps' bidirectional test. This screen was shown for 5 minutes, and the same timer as the learning section of the web application was used to make the users aware of the time left. There were three columns on the test page titled 'the word', 'meaning of the word', and 'whatever you remember' in the participants' native language (Persian), respectively (Figure 21). After 5 minutes, the answers were saved automatically.

3.5.2.6 Game/distracting Page

To meet Mirzaei et al. (2018) and Wyra et al. (2007) study requirements, participants were to be distracted in phases (1), (2), and (3) of the study as shown in Table 9. The main reason for this distracting activity was to stop participants from thinking about

a) the strategy before showing the word-pairs in the learning section (transition from phase 1 to 2) and

b) the presented word-pairs before engaging in the testing sections of the experiments (transitions from learning to testing in phases 2 and 3).

For this purpose, in phase (1) the participants were engaged in a casual conversation not related to the learning task while in phases (2) and (3) they were engaged in a short, low cognitive load task within the web application. As shown in Figure 20, a simple algorithm was designed, which had a game-like approach; the user was asked to click on the green cell within a specific time frame while the green cell's position on the screen was changing constantly. The game difficulty level was increased based on the speed of the green cell's movements. The speed of changing the position was faster every time the user was clicking on the right green cell.

The distraction activity took the same amount of time as the P&P groups (3 minutes) and was facilitated by the researcher.

3.5.2.7 SUS Questionnaire

The SUS questionnaire included ten questions to test usability and learnability of the web application. The questionnaire was in Persian; however, an English translated version of this questionnaire is shown in Figures 22 and 23 for demonstrations purposes. The actual Persian SUS questionnaire is available in Appendix (VI).

Device	ID
XX	

Please circle the number that best describes your feelings towards the <method> in relation to the tasks you have just completed:

1. **I think that I would like to use this method frequently**

Strongly disagree				Strongly agree
1	2	3	4	5

2. **I found the method unnecessarily complex**

Strongly disagree				Strongly agree
1	2	3	4	5

3. **I thought the method was easy to use**

Strongly disagree				Strongly agree
1	2	3	4	5

4. **I think that I would need the support of a technical person to be able to use this method**

Strongly disagree				Strongly agree
1	2	3	4	5

5. **I found the various functions of this method well integrated (e.g. camera, screen, audio)**

Strongly disagree				Strongly agree
1	2	3	4	5

More questions over page

Figure 22. SUS questionnaire page 1

6. **I thought there was too much inconsistency with this method**

Strongly disagree				Strongly agree
1	2	3	4	5

7. **I would imagine that most people would learn new vocabulary items via this method very quickly**

Strongly disagree				Strongly agree
1	2	3	4	5

8. **I found the method very awkward to use**

Strongly disagree				Strongly agree
1	2	3	4	5

9. **I felt very confident using the method**

Strongly disagree				Strongly agree
1	2	3	4	5

10. **I needed to learn a lot of things before I could get going with this method**

Strongly disagree				Strongly agree
1	2	3	4	5

Figure 23. SUS questionnaire page 2

The SUS questionnaire shown in Appendix (VI) was printed and provided to the app group participants.

3.6 Data Collection and Data Analyses Methods

In the current study, the interest was on usability, learnability, and applicability of the web application along with the vocabulary learning and recall of learnt vocabulary of FL learners. Accordingly, the web application was designed to evaluate the efficacy and usability of technology in learning a learning strategy (e.g., the KWM) and applying this learning strategy in the learning of new vocabulary in a CALL context.

At the early stages of this research study, five broad RQs were considered. Table 13 lists these RQs along with the corresponding analysed data and study phases.

Table 13. RQs, analysed data, and phases

RQ	Analysed Data	Phases
RQ1	KWM vs ctrl groups ('KWM – enc' and 'KWM - ret' vs 'ctrl') word-set 1 forward ('F': first 11 words) and backward ('B': second 11 words) recall for app and P&P methods	2
RQ2	KWM groups ('KWM – enc' vs 'KWM - ret') word-set 1 forward ('F': first 11 words) and backward ('B': second 11 words) recall for app and P&P methods	2
RQ3	KWM vs ctrl groups ('KWM – enc' and 'KWM – ret' vs 'ctrl') word-set 1 forward ('F': first 11 words) and backward ('B': second 11 words) recall for app and P&P methods within factor of time (T1 vs T2, T3, and T4)	2
RQ4	KWM groups ('KWM – enc' vs 'KWM – ret') word-set 1 and 2 comparison of forward ('F': first 11 words) and backward ('B': second 11 words) recall for app and P&P methods with within factor of time (T1 vs T2, T3, and T4)	3
RQ5	KWM vs ctrl groups ('KWM – enc' and 'KWM – ret' vs 'ctrl') SUS specific participant answers and comparison of overall SUS scores in the app method	4

3.7 Data preparation

As the name suggests, the P&P participants' data was collected as hard copies and for backup purposes, the hard copies were scanned. These digital copies were stored on Flinders University secure research network drives. The digital copies of the P&P groups were validated and manually transferred into excel sheets so that it could be imported to SPSS version 27 for data analyses. For the app participant groups, after all phases of the experiment were completed and the data was collected, the final database was selected in phpMyAdmin, and the export tab was used to export the data as a compressed file to secured network research drives. After some data wrangling tasks (data cleansing, data transformation, and data enrichment) and data profiling, the data was recorded and input manually in Excel spreadsheets for experiment data analysis tasks and finally imported into SPSS version 27. The data wrangling tasks were conducted manually as some data required some initial validation (e.g., 'the whatever you remember column') and the P&P data required manual handling (i.e., entering the data from hard copies into Excel).

The validation procedure included identifying and verifying all questionnaires and recall test participants' responses and categorising these data by checking every data cell. The validated data was then put into the finalised excel spreadsheets. The app participants' data which was already stored on the web application databases was also stored and backed up on the same secure research network drives. The aforementioned excel sheets and SPSS analyses outcome data were stored on the same network drives, too.

3.8 Chapter 3 Summary

This chapter discussed the research methods and procedures employed in the current research study, as well as the instruments to aid study design (i.e., the booklets and the web application).

Please note that the underlying theoretical framework and rationale behind the study design was already discussed in section 2.3.

This study employed a quantitative, experimental research design. The independent variables were the time, word-sets 1 and 2, and the strategy (different outcome for different strategies) for

a) web application based KWM (app)
b) traditional KWM (P&P)

c) control (ctrl) (learners' own/usual vocabulary learning strategy).

Dependent variables were the word recall scores (components 1 and 2 of the study) and SUS scores (component 3 of the study). Vocabulary learning via the KWM was the focus of components 1 and 2 of the study, while a SUS questionnaire was used in component 3 of the study to assess the usability of the developed web application.

This chapter detailed the experimental study designs of components 1, 2 and 3 (Table 9) of the study by providing the study design details in section 3.1, the participants in section 3.2, the procedures in section 3.3, the study designs and RQs in section 3.4, material and tools in section 3.5, data collection and methods of data analyses in section 3.6, and data preparation in section 3.7.

In the Chapter 4, the current study analyses findings are discussed in detail.

4 ANALYSES AND FINDINGS

This chapter discusses the analyses and finding of the present study. Forward and backward vocabulary recall analyses and findings are discussed in 4.1. Next, the web application usability findings are discussed in 4.2 and overall vocabulary recall analysis is presented in the section 4.3. The chapter summary is available in section 4.4.

As shown in Table 9, there were total of six participant groups in two experimental and one control groups in a balanced within–between design (n = 40). These groups were formed based on the teaching intervention; that is, students have learned how to use the KWM to learn new word-pairs, and the methods of teaching/learning and testing delivery (i.e., P&P or app). Accordingly, the following groups were considered

- KWM encoding training groups (experimental): app or P&P.
- KWM encoding and retrieval training groups (experimental): app or P&P.
- No strategy training: that is, own strategy groups (control): app or P&P.

Albert and Tullis (2013) outlined that the means comparison can be conducted via utilising a z-test or t-test based on attributes (e.g., sample size and number of samples) and considered the categories for choosing the correct test(s) based on sample size (a sample size of less than 30 requires a t-test, while a sample size greater than 30 requires a z-test) and number of compared samples (t-test for number of compared samples of 2 and Analysis of Variance (ANOVA) for number of compared samples of 3 and more). Based on Albert and Tullis's (2013) study, a mixed factor repeated measure ANOVA on word-sets 1 and 2 was conducted for components 1 and 2 of the study, respectively.

To investigate the overall SUS score, a one-way ANOVA was conducted in SPSS version 27 on collected data of components 3 of the study to compare the SUS of the app method participants. As discussed in section 3.1, dependent variables were the recall scores (components 1 and 2 of the study) and SUS scores (component 3 of the study). The components 1, 2, and 3 of the study are discussed in detail in section 3.1.1.

4.1 Forward and Backward Recall

The three independent (factor) variables for this analysis were four occasions of time (e.g., T1 for immediate recall, T2, T3, and T4 for delayed recall), intervention ('KWM – enc' for

groups who received encoding training, ‘KWM – ret’ for groups who received encoding and retrieval training and ‘ctrl’ for control groups) and method (‘app’ for groups using the web application and ‘P&P’ for groups using P&P) while the dependent (outcome) variable was the number of correctly recalled words (recall type ‘F’ and ‘B’ for forward and backward recall, respectively). The within subject variables are the four time points (T1, T2, T3, T4) and the between subject variables were the intervention (‘ctrl’, ‘KWM – enc’, ‘KWM – ret’) and method (P&P, app) (Table 9). To investigate vocabulary recall, two three by two (3*2) mixed factor ANOVA with repeated measure tests were conducted in SPSS version 27 for word-sets 1 and 2 for components 1 and 2 of the study, respectively. Tables 14 and 15 show the descriptive statistics including mean recall and standard deviations (SD) for components 1 and 2 of the study, respectively.

Table 14. Forward and backward recall means and SD for component 1 of the study (word-set 1, n = 240)

Recall Type	Time	Intervention	Method	Mean Recall (SD)
Forward	T1	ctrl	P&P	7.12 (1.89)
			app	4.92 (1.78)
		KWM - enc	P&P	10.60 (0.74)
			app	10.75 (0.58)
		KWM - ret	P&P	9.90 (0.84)
			app	10.17 (0.95)
Forward	T2	ctrl	P&P	6.95 (2.08)
			app	4.42 (1.82)
		KWM - enc	P&P	10.37 (0.92)
			app	10.75 (0.58)
		KWM - ret	P&P	9.67 (0.94)
			app	10.17 (0.95)
Forward	T3	ctrl	P&P	6.50 (2.35)
			app	4.50 (1.86)
		KWM - enc	P&P	10.70 (0.68)
			App	10.75 (0.58)
		KWM - ret	P&P	10.05 (0.84)
			app	10.62 (0.86)
Forward	T4	ctrl	P&P	5.95 (2.33)
			app	4.65 (1.87)
		KWM - enc	P&P	10.72 (0.67)
			app	10.75 (0.58)
		KWM - ret	P&P	10.07 (0.85)
			app	10.62 (0.86)
Backward	T1	ctrl	P&P	2.07 (1.47)
			app	5.15 (2.55)
		KWM - enc	P&P	3.02 (1.36)
			app	3.77 (1.09)
		KWM - ret	P&P	3.12 (1.04)
			app	5.00 (0.93)
Backward	T2	ctrl	P&P	1.17 (1.39)
			app	5.15 (2.55)
		KWM - enc	P&P	2.27 (1.46)
			app	3.40 (1.17)
		KWM - ret	P&P	2.82 (0.95)
			app	4.50 (1.01)
Backward	T3	ctrl	P&P	0.95 (1.35)

Recall Type	Time	Intervention	Method	Mean Recall (SD)
			app	5.62 (2.55)
		KWM - enc	P&P	3.40 (1.67)
			app	5.35 (1.45)
		KWM - ret	P&P	4.65 (1.51)
			app	6.20 (1.22)
Backward	T4	ctrl	P&P	0.75 (1.35)
			app	6.50 (2.60)
		KWM - enc	P&P	4.22 (1.98)
			app	6.25 (1.49)
		KWM - ret	P&P	5.10 (1.58)
			app	6.67 (1.22)

Table 15. Forward and backward recall means and SD for component 2 of the study (word-set 2, n = 240)

Recall Type	Time	Intervention	Method	Mean Recall (SD)
Forward	T1	ctrl	P&P	6.97 (1.90)
			app	5.02 (1.99)
		KWM - enc	P&P	10.87 (0.33)
			app	10.95 (0.22)
		KWM - ret	P&P	9.52 (0.98)
			app	10.17 (0.95)
Forward	T2	ctrl	P&P	6.72 (2.07)
			app	4.60 (1.95)
		KWM - enc	P&P	10.82 (0.38)
			app	10.95 (0.22)
		KWM - ret	P&P	9.52 (0.98)
			app	10.17 (0.95)
Forward	T3	ctrl	P&P	6.60 (2.14)
			app	4.72 (1.96)
		KWM - enc	P&P	10.82 (0.38)
			App	10.95 (0.22)
		KWM - ret	P&P	9.85 (0.97)
			app	10.72 (0.50)
Forward	T4	ctrl	P&P	6.55 (2.14)
			app	5.22 (2.05)
		KWM - enc	P&P	10.82 (0.38)
			app	11.00 (0.00)
		KWM - ret	P&P	9.85 (0.97)
			app	10.87 (0.40)
Backward	T1	ctrl	P&P	2.57 (2.01)
			app	5.67 (2.40)
		KWM - enc	P&P	4.22 (1.62)
			app	4.52 (1.33)
		KWM - ret	P&P	4.05 (1.28)
			app	5.40 (1.12)
Backward	T2	ctrl	P&P	1.92 (1.93)
			app	5.65 (2.4)
		KWM - enc	P&P	3.10 (1.7)
			app	4.00 (1.41)
		KWM - ret	P&P	3.52 (1.37)
			app	5.02 (1.40)
Backward	T3	ctrl	P&P	2.37 (2.21)
			app	6.05 (2.27)
		KWM - enc	P&P	3.62 (1.83)
			app	5.90 (1.58)
		KWM - ret	P&P	5.07 (1.34)
			app	7.40 (1.61)

Recall Type	Time	Intervention	Method	Mean Recall (SD)
Backward	T4	ctrl	P&P	3.00 (2.57)
			app	6.92 (2.36)
		KWM - enc	P&P	4.17 (1.90)
			app	7.00 (1.81)
		KWM - ret	P&P	5.55 (1.29)
			app	7.82 (1.85)

In Tables 14 and 15, the ‘Recall Type’ column separates the recalled words outcome into forward and backward recall. The ‘Intervention’ column represents the experimental and control groups (refer to Table 9), the ‘Method’ shows the web application and P&P methods, and the ‘Time’ column shows the testing occasions.

As shown in Tables 14 and 15 and according to the between-subjects results obtained by the conducted factorial ANOVA, in both forward and backward recall (DV), intervention and method (IVs) effects were statistically significant at $p<0.05$. The main effect of intervention yielded an effect size of 0.778 and 0.114 indicating a large effect in the forward and backward recall, which was explained by intervention (forward: $F(2, 234) = 409.05$, $p<0.001$ and backward: $F(2, 234) = 15.07$, $p<0.001$). The main effect of method yielded an effect size of 0.24 and 0.403 indicating a large effect in the forward and backward recall, which was explained by intervention (forward: $F(1, 234) = 5.80$, $p=0.01$ and backward: $F(1, 234) = 157.65$, $p<0.001$).

Figures 24, 25, 26, and 27 present forward and backward recall means comparison based on intervention (‘KWM – enc’ for encoding only groups, ‘KWM – ret’ for encoding and retrieval groups and ‘ctrl’ for control groups) and recall (T1 for immediate and T2, T3, and T4 for delayed recalls) in word-sets 1 and 2. The numbers shown on the bar indicate the number of correct recalled words (out of 11 forward or 11 backward words). In Figures 24, 25, 26, and 27, the app and P&P recall numbers are averaged within each intervention group to show the average recall at each recall time.

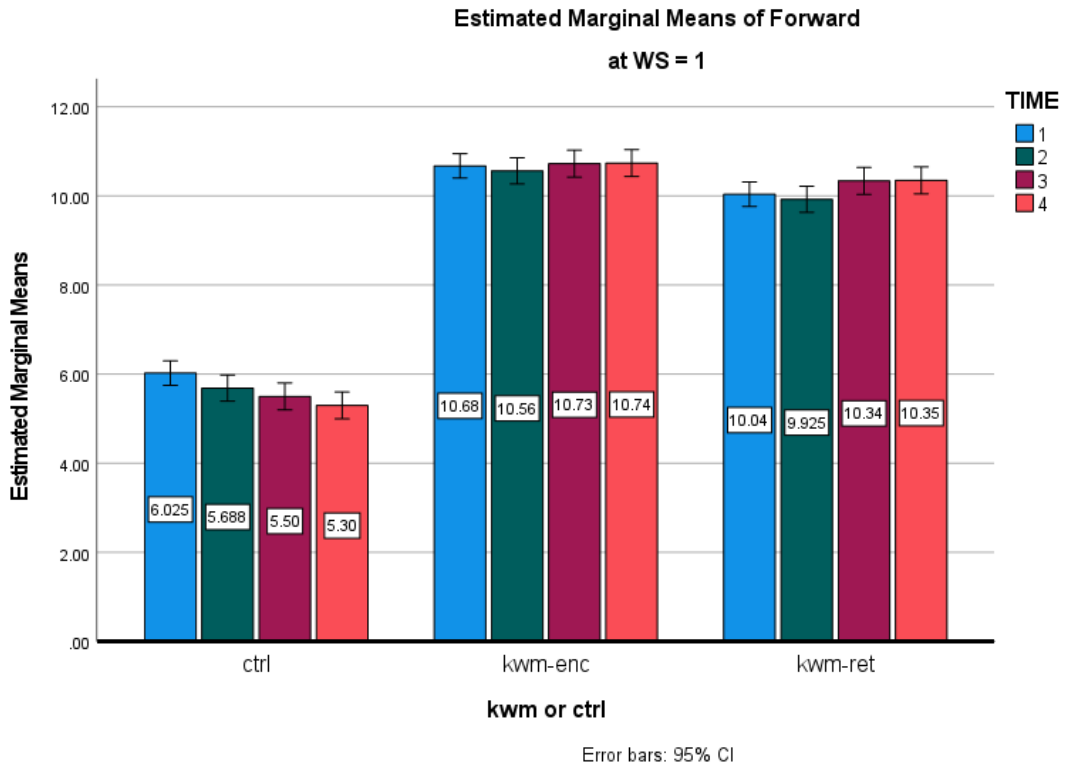


Figure 24. Forward recall for word-set 1 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on intervention – component 1 of the study (p <.002)

In Figure 24, the 'ctrl' intervention group vocabulary recall faced a downward trend from T1 (54.7%) to T4 (48.1%) while the 'KWM – enc' and 'KWM – ret' intervention groups faced an upward trend with a slight decrease in T2 (from 97% to 96%), followed by a slight increase in T3 (97.5%) and finally reaching the peak at T4 (97.6%).

Overall, as shown in Figure 24, in forward recall for word-set 1, the experimental intervention groups had higher recall rates than the 'ctrl' intervention group with the 'KWM – enc' group performing slightly better than 'KWM – ret'.

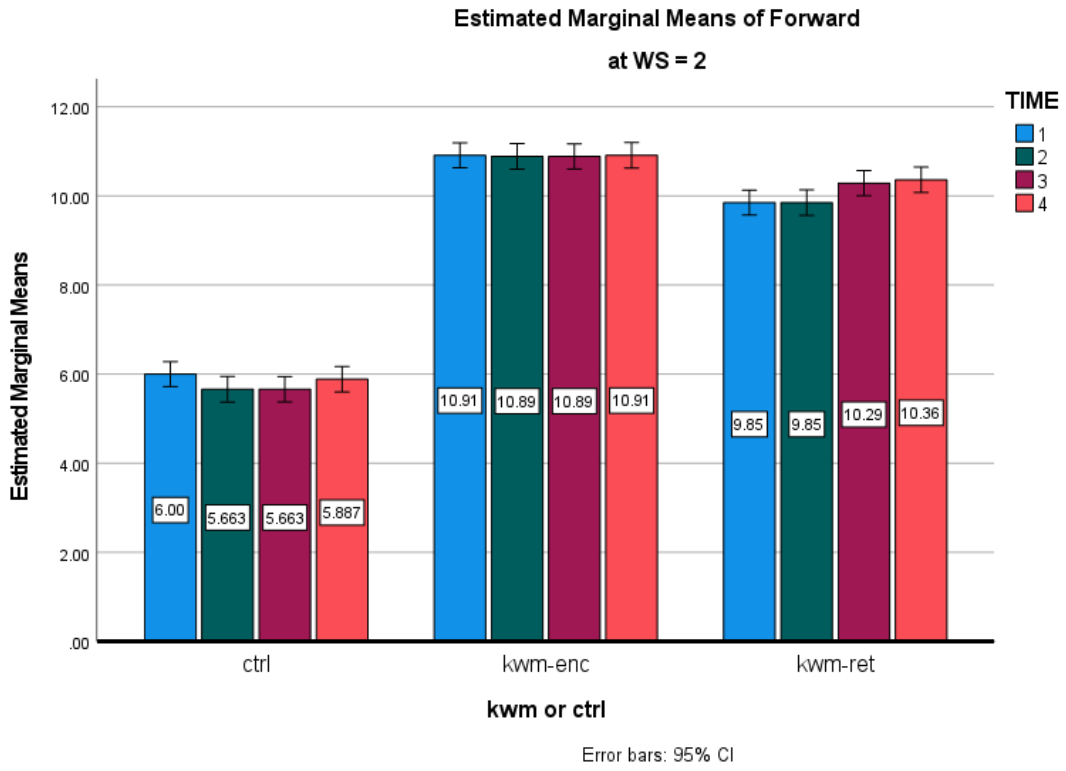


Figure 25. Forward recall for word-set 2 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on intervention – component 2 of the study (*p <.002*)

In Figure 25, the 'ctrl' intervention group vocabulary recall faced an overall downward trend starting with highest recall at T1 (54.5%) to T2 (51.48%), while keeping the same recall number in T3 as T2 and a slight increase in T4 (53.3%) from T3. The 'KWM – enc' intervention group faced a slight fluctuating trend reaching the same peak as T1 at T4 (99.1%). The 'KWM – ret' intervention group had an upward trend having the same recall numbers in T1 and T2 (89.5%), with an increase in T3 (93.5%) and the peak at T4 (94.1%).

Overall, as shown in Figure 25, in forward recall for word-set 2, the experimental intervention groups had higher recall rates than the 'ctrl' intervention group with the 'KWM – enc' group performing slightly better than 'KWM – ret'.

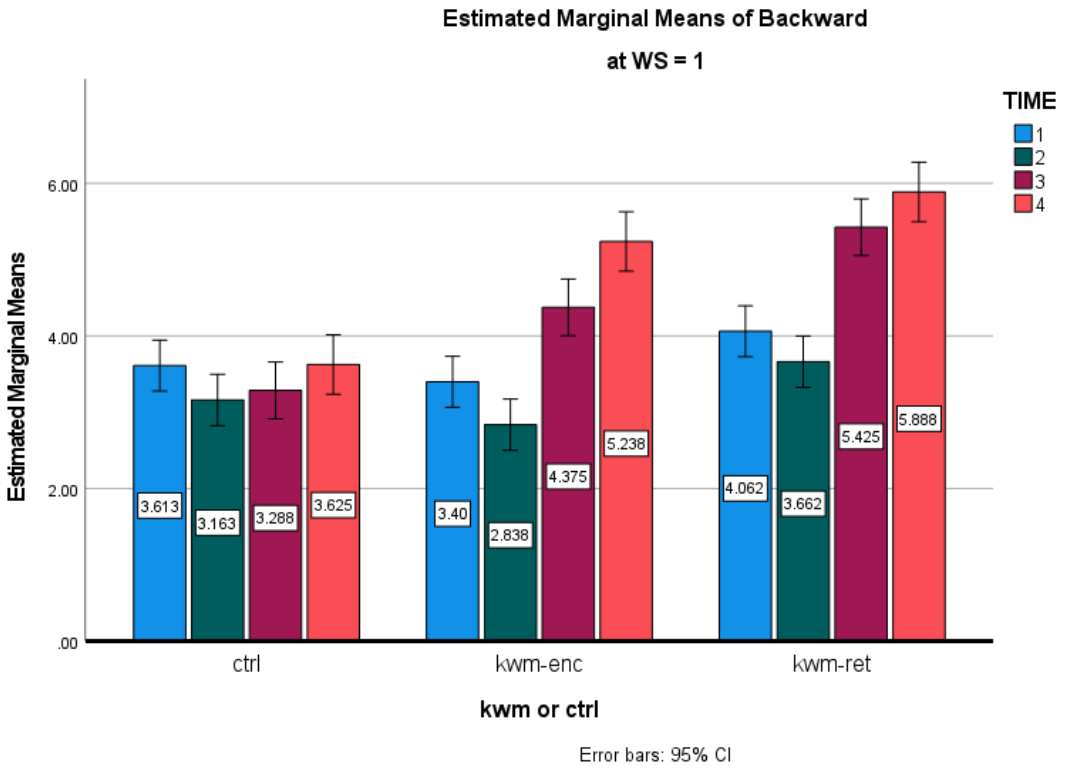


Figure 26. Backward recall for word-set 1 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on intervention – component 1 of the study (*p <.002*)

In Figure 26, the 'ctrl', 'KWM – enc', and 'KWM – ret' intervention groups faced the same overall upward trend with a slight decrease in T2 (approximately 10% decrease), followed by an increase in T3 (approximately, 10–20%) and finally reaching the peak at T4.

Overall, as shown in Figure 26, in backward recall for word-set 1, the experimental intervention groups had higher recall rates than the 'ctrl' intervention group with 'KWM – ret' group performing slightly better than 'KWM – enc'.

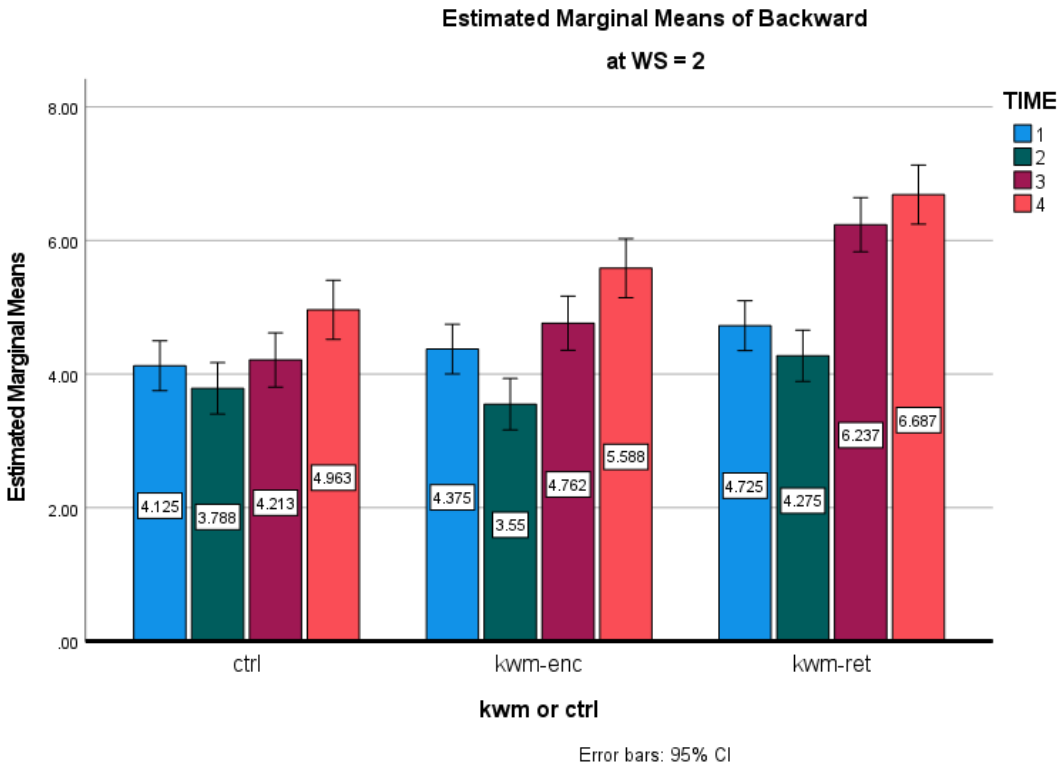


Figure 27. Backward recall for word-set 2 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on intervention – component 2 of the study (*p <.002*)

In Figure 27, the 'ctrl' intervention group vocabulary recall faced an overall upward trend with a decrease from T1 (37.5%) to T4 (45.1%) while the 'KWM – enc' and 'KWM – ret' intervention groups faced the same trend with a slight decrease in T2 (approximately, 5% decrease), followed by a slight decrease in T3 (approximately, 10–20% increase) and finally reaching the peak at T4.

Overall, as shown in Figure 27, in backward recall for word-set 2, the experimental intervention groups had higher rates than the 'ctrl' intervention group with the 'KWM – ret' group performing slightly better than 'KWM – enc'.

The trends in Figures 24, 25, 26, and 27 were quite similar to achieved trends of Wyra et al.'s (2007) study.

Figures 28, 29, 30, and 31 present the same means comparison based on the methods ('app' and 'P&P' for web application and P&P groups, respectively). In Figures 28, 29, 30, and 31, the control ('ctrl') and experimental ('KWM – enc' and 'KWM – ret') groups' recall

numbers are averaged within all intervention groups to show the average recall at each recall time for each method.

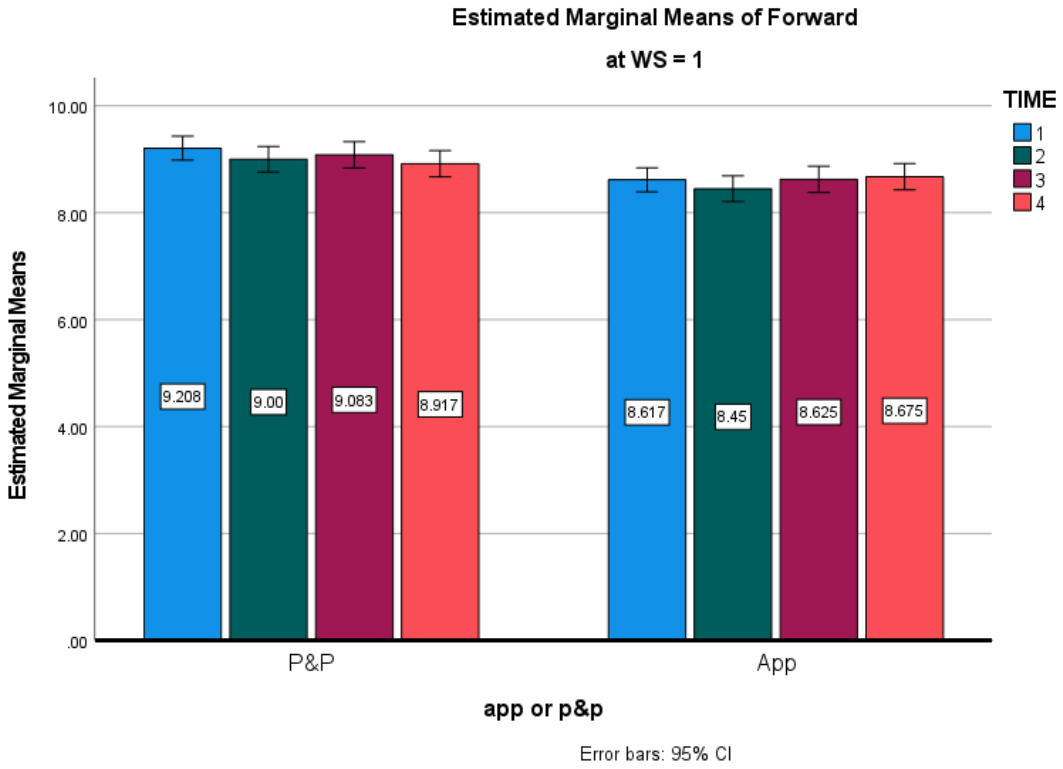


Figure 28. Forward recall for word-set 1 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on methods – component 1 of the study (p <.002)

In Figure 28, the 'P&P' method groups vocabulary recall faced an overall downward trend with a decrease from T1 (83.7%) to T2 (81.8%), a slight increase in T3 (82.5%) and further decrease in T4 (81%) while the 'app' method groups faced an upward trend with a slight decrease in T3 (less than 2%).

Overall, as shown in Figure 28, in forward recall for word-set 1, the 'P&P' groups had slightly higher rates than the 'app' ones.

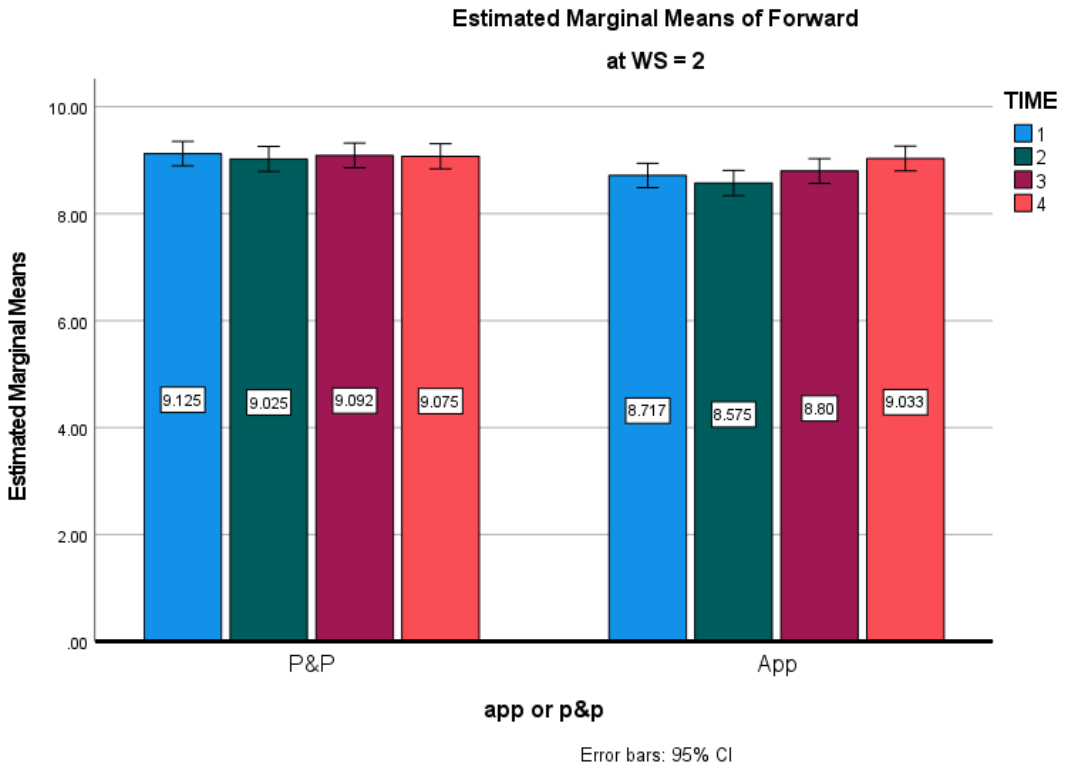


Figure 29. Forward recall for word-set 2 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on methods – component 2 of the study (p <.002)

In Figure 29, the 'P&P' method groups vocabulary recall faced an overall downward trend with a slight decrease from T1 (82.9%) to T2 (82%), a slight increase in T3 (82.6%) and further decrease in T4 (82.4%) while the 'app' method groups faced an upward trend with a slight decrease in T2 (less than 2% decrease).

Overall, as shown in Figure 29, in forward recall for word-set 2, the 'P&P' groups had slightly higher rates than the 'app'.

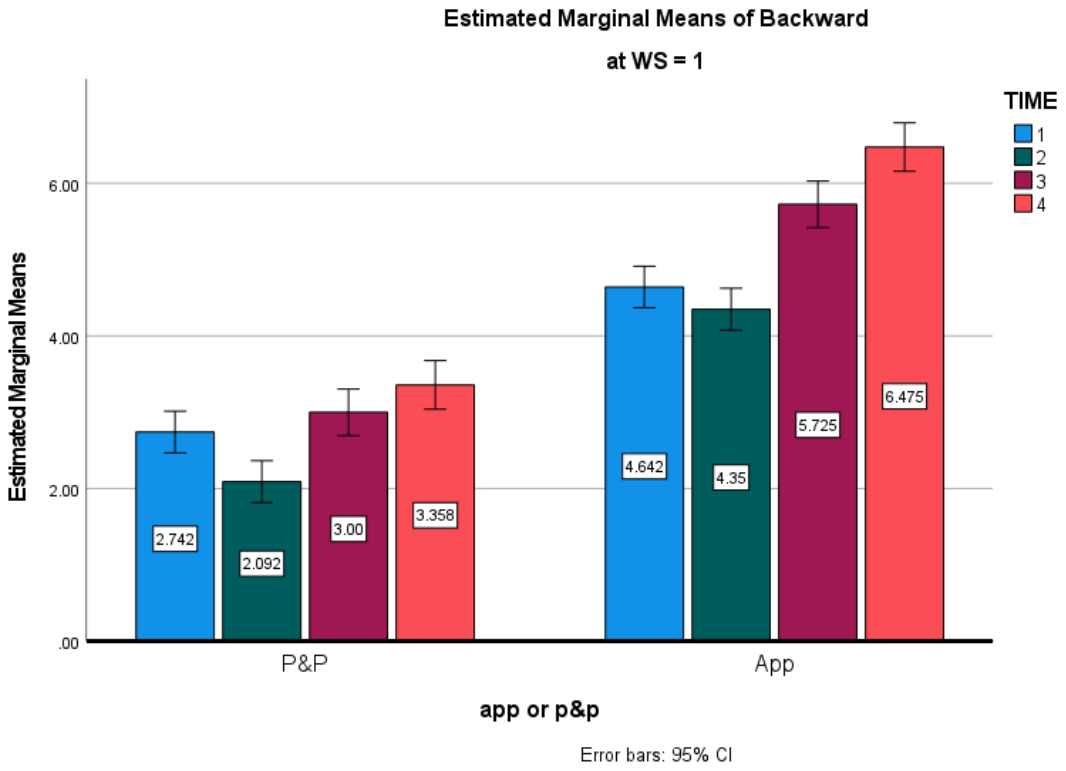


Figure 30. Backward recall for word-set 1 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on methods – component 1 of the study (p <.002)

In Figure 30, the 'P&P' and 'app' method groups' vocabulary recall faced an overall upward trend with a less than 6% decrease from T1 to T2, a slight increase in T3 (approximately 10% increase) and further increase in T4 (approximately 3–10% increase).

Overall, as shown in Figure 30, in backward recall for word-set 1, the 'app' groups had considerably higher rates than the 'P&P'.

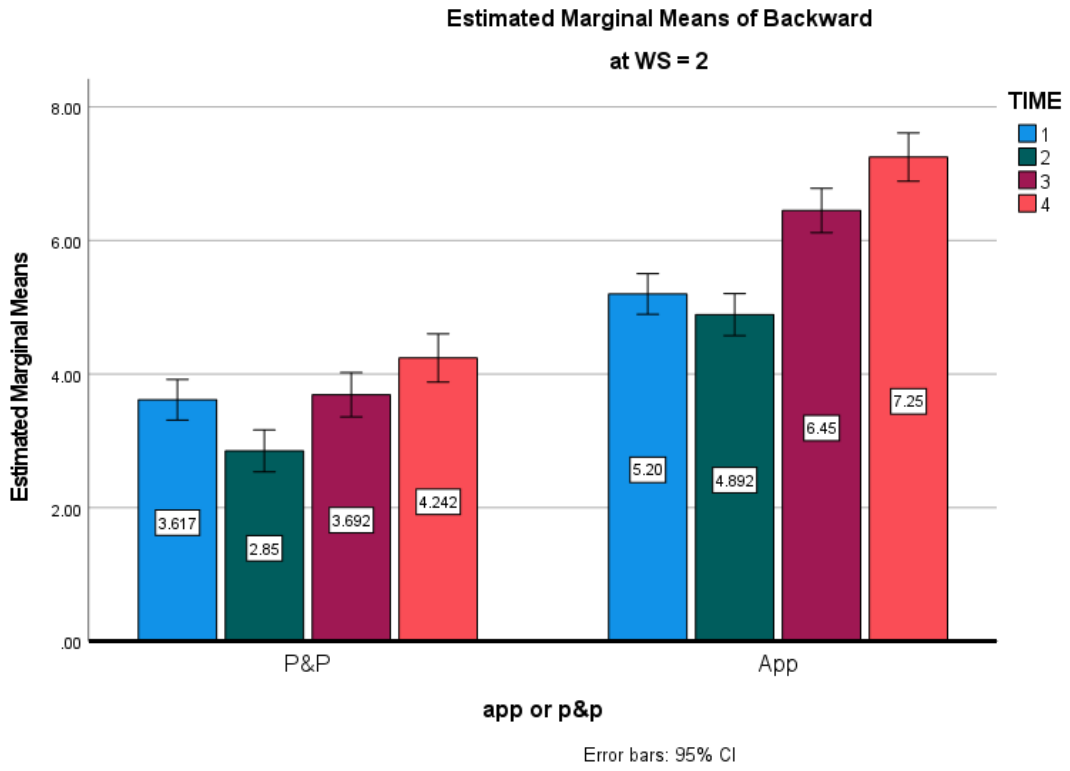


Figure 31. Backward recall for word-set 2 for immediate recall (T1) and delayed recall (T2, T3 and T4) based on methods – component 2 of the study (p <.002)

In Figure 31, the 'P&P' and 'app' method groups' vocabulary recall faced an overall upward trend with a less than 7% decrease from T1 to T2, a slight increase in T3 (approximately 10% increase) and further increase in T4 (more than 7%).

Overall, as shown in Figure 31, in backward recall for word-set 2, the 'app' groups performed considerably better than the 'P&P'.

According to the within-subjects results obtained by the conducted factorial ANOVA, in both forward and backward recall (DV), time (IV) effect was statistically significant at $p<0.001$. The main effect of time yielded an effect size of 0.221 and 0.667 indicating a large effect in the forward and backward recall (forward: $F(1, 234) = 62.47$, $p<0.001$ and backward: $F(1, 234) = 469.46$, $p<0.001$).

The 'KWM – ret' (app) group had the highest number of correct recalled forward and backward combined recalled words between all groups.

The experimental study design for component 3 of the study allowed the researcher to conduct an analysis of the collected data to provide a comparison on app methods' interventions ('ctrl', 'KWM – enc', and 'KWM – ret') with different usability measures on usability of the designed web application for the same groups discussed in components 1 and 2 of the study.

4.2 Usability Analyses and Findings

4.2.1 Usability Measures

Usability was measured for the app group participants (Table 9) using the SUS scoring model by Lewis (2018) as shown below.

(1)

$$SUS = 2.5((20 + SUM((SUS01, SUS03, SUS05, SUS07, SUS09) - SUM(SUS02, SUS04, SUS06, SUS08, SUS10))$$

On the right-hand side of the equation in the above formula, for the 'SUS#' values where '#' denotes the item number (question number), the responses ranged from 1 (strongly disagree) to 5 (strongly agree) for each of the questions in Table 7.

To investigate the overall SUS score, a one-way ANOVA was conducted in SPSS version 27 to compare the SUS of the app method participants as shown in Table 16.

Table 16. SUS means and standard deviation (n = 40 for each group)

Intervention	Mean Score (SD)
ctrl (app)	68.81 (13.25)
KWM - enc (app)	86.50 (19.65)
KWM - ret (app)	91.56 (13.78)

SUS results indicated that the average SUS score for the experimental 'KWM – ret' and 'KWM – enc' participants were 91.56% and 86.50%, respectively, and both in an 'A+' letter grade or in the 84.1–100% percentile range while 'ctrl' participants had an average of 68.81% and in the 'C' letter grade or in the 65-71% percentile range (J. R. Lewis et al., 2015)(Figure 6). This means the web application used in experimental and control groups were in 'Excellent' and 'OK' ranges, respectively (Bangor et al., 2009). Accordingly, the experimental groups ('KWM – enc': M = 86.50, SD = 19.56 and 'KWM – ret': M = 91.56, SD

= 13.78) performed much better than the control groups users ('ctrl': M = 68.81, SD = 13.25) from a usability perspective (F (2, 117) = 22.77), p=0.000). The means of SUS scores for all three groups are shown in Figure 32.

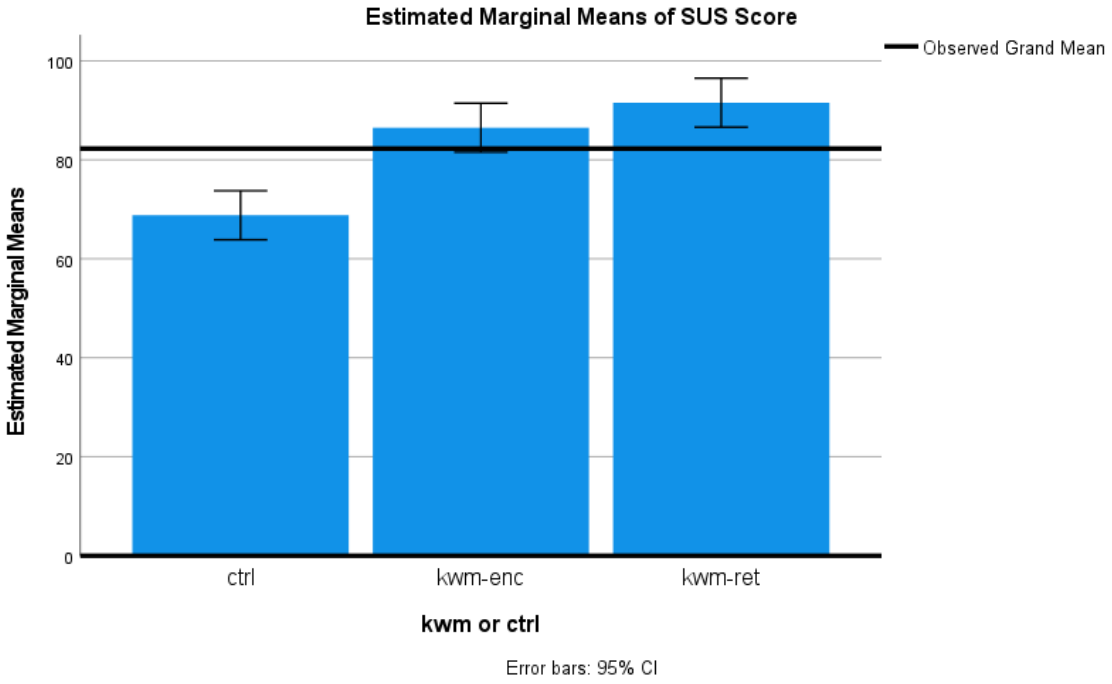


Figure 32. Overall SUS score means for all app groups

As shown in Figure 32, the 'KWM – ret' group had the highest SUS score (91.56%) followed by the 'KWM – enc' (86.50%) and 'ctrl' groups (68.81%).

4.3 Overall Recall Analysis

To analyse the overall vocabulary recall, a mixed ANOVA with repeated measures analysis was conducted without regarding the forward and backward recall (total number recalled words out of 22). In this analysis, the same six participant groups as discussed in components 1, 2, and 3 of the study were considered (Table 9).

According to the between-subjects results obtained by the conducted factorial ANOVA, in overall recall (DV), intervention and method (IVs) effects were statistically significant at $p<0.001$. The main effects of intervention and method yielded an effect size of 0.647 and 0.216 which indicates a large effect; the overall recall was explained by intervention and method (intervention: $F (2, 234) = 213.99$, $p<0.001$ and method: $F (1, 234) = 64.44$, $p<0.001$).

Based on the within-subjects results obtained by the conducted factorial ANOVA, in overall recall (DV), time and word-sets (IVs) effects were statistically significant at $p<0.001$. The main effects of time and word-sets yielded an effect size of 0.726 and 0.271 indicating a large effect; the overall recall was explained by time and word-sets (time: $F(3, 702) = 620.39$, $p<0.001$ and word-sets: $F(1, 234) = 86.98$, $p<0.001$).

The 'KWM – ret' (app) group had the highest number of correct overall recall of words between all groups.

Table 17 presents the control and experimental groups for each word-set. Tables 18 and 19 show the descriptive statistics for word-sets 1 and 2, respectively.

Table 17. Analytical test categories (n = 40 for each group, 'NA' = Not Applicable)

Group→ **Test Category↓**	**Control**	**Experimental P&P**	**Experimental app**
Control P&P versus Experimental P&P	ctrl (P&P)	KWM - enc (P&P)	NA
	ctrl (P&P)	KWM - ret (P&P)	NA
Control App versus Experimental App	ctrl (app)	NA	KWM - enc (app)
	ctrl (app)	NA	KWM - ret (app)
Experimental P&P versus Experimental App	NA	KWM - enc (P&P)	KWM - enc (app)
	NA	KWM - ret (P&P)	KWM - ret (app)

In Table 17, the first column shows the test categories, and the other columns show the available control and experimental groups.

Table 18 shows the results of the conducted mixed ANOVA with repeated measures for word-set 1, which was conducted for each possible column based on Table 17 (e.g., 'ctrl' (P&P) group with 'KWM – enc' (P&P) and 'KWM – ret' (P&P) as shown in first two rows).

Table 18. Word-set 1 statistical analysis for control (P&P and app) vs experimental (P&P and app) groups (n = 40 for each group). *: significantly different from ctrl (P&P) (p < 0.001).

	ctrl (P&P)	KWM - enc (P&P)	KWM - ret (P&P)	ctrl (app)	KWM - enc (App)	KWM - ret (app)
Mean (SD)	7.86 (2.87)	13.83* (1.93)	13.85* (1.59)	10.23 (2.84)	15.45* (1.44)	15.99* (1.03)

In Table 18, the results showed that the 'KWM – ret' (app) group had the highest recall in word-set 1 among all groups (M = 15.99, SD = 1.03).

Table 18 shows the results of the conducted mixed ANOVA with repeated measures for word-sets 2, which was conducted for each possible column based on Table 17 (e.g., 'ctrl' (P&P) group with 'KWM – enc' (P&P) and 'KWM – ret' (P&P) as shown in first two rows).

Table 19. Word-set 2 statistical analysis for control (P&P and app) vs experimental (P&P and app) groups (n = 40 for each group). *: significantly different from ctrl (P&P) (p < 0.001).

	ctrl (P&P)	KWM - enc (P&P)	KWM - ret (P&P)	ctrl (app)	KWM - enc (app)	KWM - ret (app)
Mean (SD)	9.18 (3.31)	14.61* (1.90)	14.23* (1.54)	10.97 (3.09)	16.31* (1.58)	16.90* (1.48)

In Table 19, similar to word-set 1, the results showed that the 'KWM – ret' (app) group had the highest recall in word-set 2 among all groups (M = 16.90, SD = 1.48).

According to Tables 18 and 19, the 'KWM – ret' (app) group had the highest number of correct recalled words between all groups with average of 15.9 (72%) in word-set 1 and 16.9 (76%) in word-set 2. The number of correct recalled words increased in word-set 2 in all groups. All experimental groups had an average of over 13.5 (61.3%) in word-set 1 and over 14 (63.6%) in word-sets 2. Figure 33 presents the overall analysis of recall of the 22 word-pairs in word-sets 1 and 2 on occasions one to four (T1 to T4).

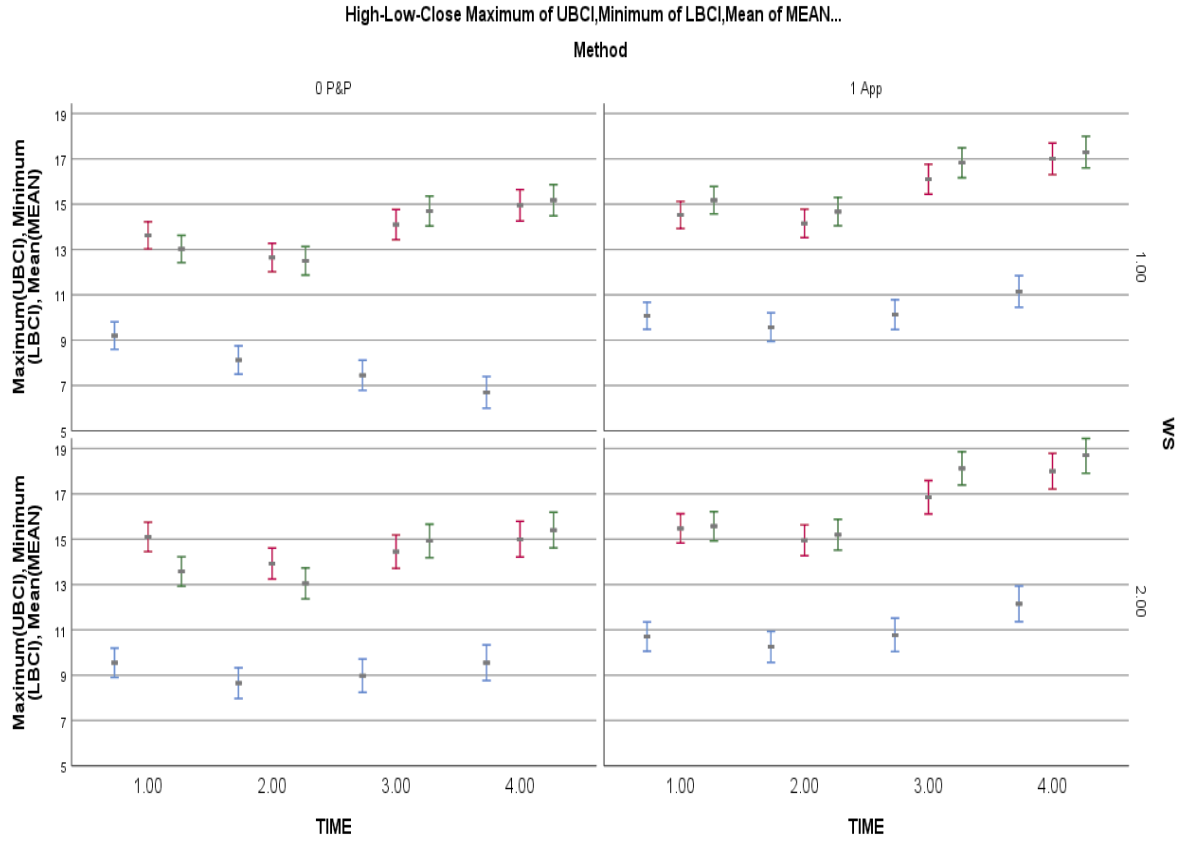


Figure 33. Overall analysis of recall in word-sets 1 and 2 (blue for 'ctrl', red for 'KWM – enc', and green for 'KWM – ret' groups)

In Figure 33, the 'ctrl' group recall is shown with blue colour while 'KWM – enc' and 'KWM – ret'' groups are presented by red and green colours, respectively. In this Figure, the methods ('0' for P&P and '1' for app) are shown at the top X axis while the bottom X axis presents the four occasions of testing (T1, T2, T3, and T4). The Y axis on the right also shows the word-sets ('1.00' for word-set 1 and '2.00' for word-set 2) while the left Y axis shows the number of recalled words. Accordingly, Figure 33 shows how recall increased over time for all groups in word-sets 1 and 2 except the 'ctrl' (P&P) group in word-set 1 while the 'KWM – ret' (app) group had the highest increase.

4.4 Chapter 4 Summary

This chapter discussed the analyses and finding of the current study. Forward and backward recall analyses and findings, usability findings, and overall recall analysis were discussed in sections 4.1, 4.2, and 4.3, respectively.

The thesis conclusion along with limitation and future research directions are discussed in Chapter 5.

5 DISCUSSION AND CONCLUSION

This chapter highlights the gains and benefits that adult learners of English experienced by using the KWM in a web application to learn Persian-English.

This chapter presents the overall discussion and conclusion on components 1, 2, and 3 of the study. In section 5.1, after presenting the RQs and study findings, a summary of the research findings are discussed. Next, the study conclusions are presented in section 5.2. In section 5.3, the current study limitations and potential future work is discussed. The thesis summary is available in section 5.4.

5.1 Discussions

In the present study, the interest was on usability, learnability, and applicability of the web application along with the vocabulary learning and recall of learnt vocabulary of FL learners. Accordingly, the web application was designed to evaluate the efficacy and usability of technology in learning a learning strategy (i.e., the KWM) and applying this learning strategy in the learning of new vocabulary in a CALL context compared to traditional P&P (the commonly used strategy in the KWM).

At the earlier stages of this research study, five broad RQs were considered

RQ1: Will the use of the KWM improve vocabulary learning outcomes?

RQ2: Will different KWM instruction methods affect vocabulary learning with KWM in different experimental groups?

RQ3: Will the KWM affect vocabulary learning short-term and long-term recall?

RQ4: Will the vocabulary learning with the KWM improve in a second word-set (without repeating the KWM instructions)?

RQ5: Is the designed web application for this study usable?

In the following subsections, the effect of the KWM and CALL (the web application) on vocabulary learning and recall along with the web application useability in the current study are discussed according to the analyses and findings discussed in Chapter 4.

5.1.1 The KWM and Recall (RQ1)

The findings presented in Chapter 4 of this thesis indicate that the KWM training had a positive effect on vocabulary recall of Persian native speakers for English vocabulary learning. In components 1 (and 2) of the study, the experimental groups ('KWM – enc' and 'KWM - ret') had the higher bidirectional recall of FL words in both app and P&P settings when compared with the control groups (Figure 33). This supports the previous study findings discussed in the literature review chapter (Chapter 2) indicating the KWM's effectiveness for FL vocabulary acquisition indicated in many studies (Beaton et al., 2005; Lawson & Hogben, 1998; Pressley, 1977; Pressley et al., 1980, 1981, 1982; Pressley & Dennis-Rounds, 1980a; Raugh & Atkinson, 1975; Wyra et al., 2007) including the literature for Persian FL vocabulary learning via the KWM (Baleghizadeh & Ashoori, 2010; Davoudi & Yousefi, 2016; Piribabadi & Rahmany, 2014; Taheri & Davoudi, 2016; Tavakoli & Gerami, 2013). Accordingly, it can be inferred that use of the KWM improves vocabulary learning outcomes. According to the patterns shown in Figure 33, for forward recall, the reason for slightly lower recall of app groups when compared to P&P groups might be the web application being distracting at first until the learners became accustomed to using it. It is also possible to consider that P&P participants benefited from the kinaesthetic act of writing/drawing. However, in backward recall, the recall in app groups outperformed the P&P groups considerably.

5.1.2 The KWM Instructions and Recall (RQ2)

In components 1 (and 2) of this study, KWM strategy instruction were in two forms of

a) encoding and
b) encoding and retrieval.

The present study's research findings (Chapter 4) indicate that for all word-sets and occasions, the encoding and retrieval groups strategy instruction form (form b) within the same method (e.g., 'KWM – enc' (P&P) and 'KWM – ret' (P&P)) resulted in slightly higher bidirectional recall when compared with the encoding (only) form (form a) (Figure 33). However, when considering the different delivery methods (i.e., app vs P&P), the bidirectional recall of for the app methods (i.e., the participants who utilised the web application) were higher no matter what forms were used. For instance, 'KWM – enc' (app) had higher bidirectional recall than 'KWM – ret' (P&P). As delineated by literature of Persian FL vocabulary learning with CALL, (Alavinia & Qoitassi, 2013; Dashtestani, 2016; Ebadi & Ghuchi, 2018; Farivar & Rahimi, 2015; Khabiri & Khatibi, 2013; Namaziandost et al., 2021;

Nejati et al., 2018; Sadeghi & Dousti, 2013; Shams, 2013; Shokrpour et al., 2019) learners' autonomy and positive attitude towards CALL could be a factor for app groups' higher rate of recall. Accordingly, it could be indicated that the encoding and retrieval KWM strategy instruction (form b) and the developed web application use for learning and utilising the KWM to learn new words contributed to the higher recall rates.

5.1.3 The KWM and Short and Long-term Recall (RQ3)

According to the experimental study designs of components 1 (and 2) of this study, vocabulary recall was tested on four occasions to test short and long-term recalls. As indicated by findings in Chapter 4, vocabulary recall increased over time with a slight decrease in the second occasion. The group with encoding and retrieval instruction who utilised the KWM via the web application ('KWM – ret' (app)) had the highest recall rates. Based on the analysis and findings of Chapter 4 and the discussed literature in Chapter 2 (e.g., Paivio & Desrochers, 1979; Shapiro & Waters, 2005), it can be suggested that pairing repetition that occurs during the testing (having several test occasions) with the KWM and use of CALL (the web application) can result in higher recall rates. As reviewed in Chapter 2, the dual-coding theory (Paivio, 1971) and the information processing elements of the KWM (association, elaboration, and imagery link) were the primary reasons of the KWM success. Also, as discussed in section 2.2, the enriched technology-based learning experience resulted from the embedded technology affordances (e.g., Kukulska-Hulme, 2009) in the designed web application could be the reason for the highest recall rate of the app groups and the increase of recall over time.

5.1.4 Word-set 2 Recall Post Learning without Instructions (RQ4)

In the current study, the main difference between word-sets 1 and 2 were between the KWM strategy instructions; in word-set 2, no strategy instruction was given to the participants. This was the main goal of component 2 of the study to see if the strategy learning (component 1) effect was reflected in the second vocabulary set (component 2) learning success.

The findings in Chapter 4 show that the participants' vocabulary recall improved in word-set 2. This could suggest that the learners' expertise in the use of the KWM improved as they have applied the use of the method on this second learning occasion.

5.1.5 The Web Application Usability (RQ5)

Based on the findings presented in Chapter 4, the developed web application was highly usable. One of the factors contributing to the high SUS score of the experimental web

application could be the guided tasks design originated from the nature of the KWM strategy instructions. Another factor could be utilisation of proper UX, UI, and user interaction principles in this web application as discussed in detail (section 2.5.4). Also, the models and frameworks considerations as discussed (section 2.3) could result in the success of the technology affordances and proper CALL implementation in the designed web application for the present study.

5.1.6 The Web Application and Recall (RQ1-5)

The point of distinction between the present study and other studies is that none of the discussed (and investigated) literature experimented with the use of a web application (CALL) for teaching a strategy (the KWM) and utilising that strategy for FL vocabulary learning and testing for Persian native speakers for English vocabulary learning. As outlined in Chapter 3, a web application was designed and developed to specifically teach the KWM, teach vocabulary via the KWM, and test the learnt vocabulary within this web application.

Findings in Chapter 4 for components 1 and 2 of the study revealed that the participants who used the web application had higher rates of recall than traditional P&P participants. This is in line with the discussed literature outlining CALL's effectiveness in increasing FL vocabulary learning (e.g., Horst et al., 2005; Kilickaya & Krajka, 2010). As discussed by Lu (2008), this could be due to benefits of CALL such as ubiquity, fun, effective time management, manageable amount of content, and being helpful for vocabulary learning. As discussed in sections 2.3.1 and 2.3.2, employing the principles outlined by Koole's FRAME model (Koole, 2006, 2009; Koole & Ally, 2006), Ma's memory-based strategic model, and Ma's technology-mediated L2 lexical applications framework (Ma, 2013, 2014, 2017) to design the web application could be one of the primary reasons for the higher recall rates as well. Another reason could be participants' motivation as a result of technology use (Derakhshan & Khodabakhshzadeh, 2011). As supported by some literature for Persian FL vocabulary learning with CALL, learners' autonomy and positive attitude towards CALL could be another factor (Alavinia & Qoitassi, 2013; Dashtestani, 2016; Ebadi & Ghuchi, 2018; Farivar & Rahimi, 2015; Khabiri & Khatibi, 2013; Namaziandost et al., 2021; Nejati et al., 2018; Sadeghi & Dousti, 2013; Shams, 2013; Shokrpour et al., 2019).

5.2 Conclusions

The web application designed and developed for this thesis – previously introduced as VLASTWA (**V**ocabulary **L**earning **a**nd **S**trategy **T**eaching **W**eb **A**pplication), showed its potential for educational environment usage; however, as this is one of the first and early

investigations of its kind, further development and experimental research are essential to improve and extend the inherent use of the designed web application for future studies.

Components 1 and 2 of the study findings suggest that the KWM use in the experimental groups gave a noticeable learning advantage in the number of words that were recalled correctly when compared with the control groups. Also, a comparison of the experiment's collected data indicated that use of the web application for vocabulary acquisition with the KWM not only bestows the same vocabulary learning effectiveness but also gives a significant advantage in learning vocabulary. The conducted experimental research revealed that the KWM can be easily embedded in the web application from learnability (component 3 of the study) and pedagogical (components 1 and 2 of the study) perspectives and the web application can be utilised as an effective apparatus in learning new words. Derakhshan and Khodabakhshzadeh (2011) discussed how vocabulary learning with computer assistance helps in difference stages of the learning process by encouraging engagement, assessment, teaching, and practice. The current study reported here reflected these elements. According to the obtained results, the KWM can be embedded in the web application environment to build an effective medium facilitating an increase of participants' vocabulary knowledge while improving vocabulary learning from both usability and pedagogical points of view. Apart from the merit of using technology for vocabulary learning in CALL (Derakhshan & Khodabakhshzadeh, 2011), specifically in web applications, the embedded affordances in the UX and UI play a crucial role. As discussed by Hartson (2003), there are four types of cognitive, physical, sensory, and functional affordances that were reflected in this thesis. Some of the examples of each of the specified affordance types in the designed web application for this study are

a) the page and button labels and keyword highlighting (cognitive),
b) the suitable (large enough) size of buttons to increase clickability (physical),
c) the appropriate size of word-pair and highlighted keyword at the teaching/learning sections of the web application (sensory), and
d) the distraction game and bidirectional test elements (functional).

5.3 Limitations and Future Work

One of the limitations of the present study is that it only focused on Persian learners aged between 18 to 60. An investigation on children and teenagers might offer further insights.

As this study was effective in the classroom settings, teachers could initially use the same procedures in the classroom settings and as they develop new vocabulary sets for students to learn, students would be encouraged to use the web application in their own time.

Web application developers could extend this application/or make it user friendly for teachers to be able to update the vocabulary lists to provide new vocabulary sets for students' continuous use throughout the course. The developers should have technology affordances in mind when doing so.

Investigating the effectiveness of this application with other languages would further increase our understanding of the effectiveness of the KWM as used in the app environment. Furthermore, it would be beneficial to investigate recall of learned vocabulary with a greater time-lapse. Similarly, it would be instrumental to explore whether there is a difference between experimenter-generated keywords and participant-generated keywords for Persian native speakers learning English vocabulary.

The idea of using other technologies to compare them with the current web application is also appealing. For instance, incorporating AR in a follow-up study since it can be conducted in a game-like approach and combining it with location-based, environmental-based, and situation-based learning could be interesting. Also, VR could be utilised in conjunction with AR and with the same principle. Furthermore, an investigation of the effects of social interaction and gamification on learners' motivation levels could be conducted via utilising a gameboard with social media sharing feature. In future studies, a scoreboard could be utilised to track learners' progress. Use of game elements and embedded gamification in vocabulary learning and testing tasks can increase learners' motivation (as discussed in section 2.2.1.1).

Furthermore, learning and engagement verification mediums such as electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI) could be utilised to expand and broaden the inherent use of the developed web application. For instance, EEG and fMRI (two of the popular neuroimaging techniques applied in neuroscientific research studies) could be utilised to monitor brain events for vocabulary processing (e.g., Kang et al., 2020; Tan, 2016). EEG allows this evaluation by measuring the electrical potential changes at the scalp as such alternations indicates postsynaptic potentials of the neurons (e.g., pyramidal cells of the neocortex) (Luck, 2014). Then, averaging segments of EEG of the specific time-locked stimulus allows isolation of patterns of potential change aligned with distinct cognitive processes (event-related potentials (ERPs)). These ERPs are triggered by a specific

event/task. Because of the phase and power of EEG in certain frequency bands, it is considered as a reliable measurement of cognitive aspects such as arousal and attention (Bonnet et al., 1992; Kang et al., 2020; Schier, 2000).

Finally, this study was conducted in a closed classroom environment to allow for controlling for extraneous variables. Accordingly, this removed elements of authentic use of the web application in real environments. As a result, the artificial environment of the study is considered a potential limitation. In future studies, this web application can be utilised in a more naturalistic environment to compare results with the current study.

5.4 Thesis Summary

While vocabulary learning takes time, in my experience as an Iranian FL learner, the emphasis on vocabulary learning in Iran is still on transmissive learning, teaching, and repetition rather than teaching learners self-regulated approaches. My personal motivation for pursing this study was, and still is from a desire to learn more effectively using technology and effective learning strategies. During my PhD research, I conducted a thorough enquiry to see if a technology-based environment with a solid underlying vocabulary learning strategy is available for English–Persian vocabulary learning. However, I was unsuccessful in identifying such research studies or technology-based platforms. Therefore, I attempted to address and fill this gap by developing and testing a technology-based environment (web application) for Persian native speakers for English vocabulary learning and vocabulary recall testing utilising a mnemonic learning strategy (the KWM).

The goal of this study was to find ways to help people acquire new vocabulary. The KWM was used as the learning strategy and was employed in a web application. Through the use of an experimental study design, the present study was framed within the scope of vocabulary acquisition and learning of FL learners' short and long-term retention.

One of the main goals of this research was to investigate CALL employment for vocabulary acquisition and teaching, particularly with the use of web applications as a resource with the KWM embedded in the application. The current study looked at learning outcomes rather than just providing the tool for delivering knowledge. The goal was to develop and evaluate a technology-based environment (web application designed based on sound development principles) that might help learners improve their declarative and procedural knowledge by following pedagogically sound methods. The use of technology for explicit vocabulary

learning strategy instruction and vocabulary learning and testing was investigated in this study by

1. Demonstrating how to utilise the KWM to learn new words and their meanings in a step-by-step manner.
2. Using examples to model the use of the KWM.
3. Offering opportunities for guided practise.
4. Including self-directed learning of new vocabulary.
5. Enabling learners to assess their own learning outcomes.
6. Using a technology-based environment (web application) to increase learning satisfaction.

The effectiveness of the KWM taught within the designed web application (app) or traditional pen and paper (P&P) was compared in this longitudinal study (n = 240, age 18+) between four experimental (two P&P and two app groups) and two control groups (one app and one P&P). The experimental groups received different encoding or encoding and recall KWM instructions. Participants in the experimental groups learned to use the KWM, used it to learn 2 word-sets of 22 new (English) words, and tested their bidirectional recall of the newly learned vocabulary using the app and P&P methods on four different test occasions, whereas participants in the control groups did not receive any KWM instruction.

The findings indicated that the web application was usable and learnable across the experimental groups and an effective instrument for learning new vocabulary, with an average vocabulary recall of 72% in word-set 1 and 76% in word-set 2. The results highlighted how this interactive and meaningful web application can complement and enhance FL vocabulary learning. However, since this is the first research of its kind, further design, development, and experimental studies are required to maximise the potential use of the designed web application in future studies.

REFERENCES

About phpMyAdmin. PhpMyAdmin official website. (2018).

AbuSeileek, A. F. (2012). The effect of computer-assisted cooperative learning methods and group size on the EFL learners' achievement in communication skills. *Computers & Education*, *58*(1), 231–239. https://doi.org/10.1016/j.compedu.2011.07.011

Agramonte, V., & Belfiore, P. J. (2002). Using mnemonics to increase early literacy skills in urban kindergarten students. *Journal of Behavioral Education*, *11*(3), 181–190. https://doi.org/10.1023/a:1020178020059

Akbari, Z. (2015). Current challenges in teaching/learning English for EFL learners: The case of junior high school and high school. *Procedia-Social and Behavioral Sciences*, *199*, 394–401.

Alavinia, P., & Qoitassi, K. (2013). On the viability of vocabulary learning enhancement through the implementation of mall: The case of Iranian EFL learners. *Journal of Language Teaching & Research*, *4*(2).

Albert, W., & Tullis, T. (2013). *Measuring the user experience: Collecting, analyzing, and presenting usability metrics*. Newnes.

Alemi, M., Meghdari, A., & Haeri, N. S. (2017). *Young EFL learners' attitude towards rall: An observational study focusing on motivation, anxiety, and interaction*. Springer International Publishing.

Al-Jarf, R. S. (2004). The effects of web-based learning on struggling EFL college writers. *Foreign Language Annals*, *37*(1), 49–57. https://doi.org/10.1111/j.1944-9720.2004.tb02172.x

Allen, C., Hadjistassou, S. K., & Richardson, D. (2016). *Self-evaluation using iPads in EFL teaching practice*. Research-publishing.net.

Almekhlafi, A. G. (2006). The effect of computer assisted language learning (CALL) on United Arab Emirates English as a foreign language (EFL) school students' achievement and attitude. *Journal of Interactive Learning Research*, *17*(2), 121–142.

Alshahrani, A. (2016). Communicating authentically: Enhancing EFL students' spoken English via videoconferencing. *CALL-EJ*, *17*(2), 1–17.

Alshammari, R., Parkes, M., & Adlington, R. (2017). Using WhatsApp in EFL instruction with Saudi Arabian university students. *Arab World English Journal*, *8*(4), 68–84. https://doi.org/10.24093/awej/vol8no4.5

Amaral, L. A., & Meurers, D. (2011). On using intelligent computer-assisted language learning in real-life foreign language teaching and learning. *ReCALL*, *23*(1), 4–24. https://doi.org/10.1017/s0958344010000261

Anderson, J. R. (2005). *Cognitive psychology and its implications*. Macmillan.

Anonthanasap, O., Ketna, M., & Leelanupab, T. (2015). *Automated English mnemonic keyword suggestion for learning Japanese vocabulary*. 638–643.

Antoniadis, G., Échinard, S., Kraif, O., Lebarbé, T., Loiseau, M., & Ponton, C. (2004). *Mirto: A new approach for CALL systems*. 147–156.

Anwar, K., & Husniah, R. (2016). Evaluating integrated task based activities and computer assisted language learning (CALL). *English Language Teaching*, *9*(4), 119. https://doi.org/10.5539/elt.v9n4p119

Appleton, J. V., & King, L. (2002). Journeying from the philosophical contemplation of constructivism to the methodological pragmatics of health services research. *Journal of Advanced Nursing*, *40*(6), 641–648. https://doi.org/10.1046/j.1365-2648.2002.02424.x

Arifani, Y., Rosyid, H., Husniah, R., & Paulina, P. (2018). Mentoring English senior high school teachers in EFL reading class using collaborative Pamanpintermu at Smam Bungah Gresik. *Kontribusia (Research Dissemination for Community Development)*, *1*(1), 17. https://doi.org/10.30587/kontribusia.v1i1.252

Arnaud, P. J., & Béjoint, H. (1992). *Vocabulary and applied linguistics*. Springer.

Asher, J. J. (1969). The total physical response approach to second language learning*. *The Modern Language Journal*, *53*(1), 3–17. https://doi.org/10.1111/j.1540-4781.1969.tb04552.x

Askell-Williams, H., Lawson, M. J., & Skrzypiec, G. (2011). Scaffolding cognitive and metacognitive strategy instruction in regular class lessons. *Instructional Science*, *40*(2), 413–443. https://doi.org/10.1007/s11251-011-9182-5

Atkinson, R. C. (1975). Mnemotechnics in second-language learning. *American Psychologist*, *30*(8), 821–828. https://doi.org/10.1037/h0077029

Atkinson, R. C., & Raugh, M. R. (1974). *An application of the mnemonic keyword method to the acquisition of a Russian vocabulary*. Defense Technical Information Center.

Atkinson, R. C., & Shiffrin, R. M. (1968). *Human memory: A proposed system and its control processes*. Elsevier.

Averill, J., Chambers, E., & Dantas-Whitney, M. (2000). Investing in people: Not just flashy gadgets. *Technology-Enhanced Learning Environments*, 85–98.

Baddeley, A. (1992). Working memory. *Science*, *255*(5044), 556–559. https://doi.org/10.1126/science.1736359

Baddeley, A., Eysenck, M. W., & Anderson, M. C. (2009). *Memory. Hove, England & New York*. Taylor & Francis Group.

Baddeley, A., Gathercole, S., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological Review*, *105*(1), 158–173. https://doi.org/10.1037/0033-295x.105.1.158

Baddeley, A., & Hitch, G. (1974). *Working memory*. Elsevier.

Baleghizadeh, S., & Ashoori, A. (2010). The effect of keyword and word list methods on immediate vocabulary retention of EFL learners. *Pakistan Journal of Social Sciences (PJSS)*, *30*(2).

Bangor, A., Kortum, P., & Miller, J. (2009). Determining what individual SUS scores mean: Adding an adjective rating scale. *Journal of Usability Studies*, *4*(3), 114–123.

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. *International Journal of Human-Computer Interaction*, *24*(6), 574–594. https://doi.org/10.1080/10447310802205776

Bani-Hani, N. A., Al-Sobh, M. A., & Abu-Melhim, A.-R. H. (2014). Utilizing Facebook groups in teaching writing: Jordanian EFL students' perceptions and attitudes. *International Journal of English Linguistics*, *4*(5). https://doi.org/10.5539/ijel.v4n5p27

bankmycell.com. (2021, June 1). How many smartphones are in the world? *How Many People Have Smartphones Worldwide?* https://www.bankmycell.com/blog/how-many-phones-are-in-the-world#1579705085743-b3697bdb-9a8f

Barcroft, J. (2009). Strategies and performance in intentional L2 vocabulary learning. *Language Awareness*, *18*(1), 74–89. https://doi.org/10.1080/09658410802557535

Barrs, K. (2012). Fostering computer-mediated L2 interaction beyond the classroom. *Language Learning & Technology*, *16*(1), 10–25.

Başaran, B. Ç. (2013). *Attitudes of EFL teachers and learners towards CALL in Turkey*. *143*.

Bass, L., Clements, P., & Kazman, R. (2003). *Software architecture in practice*. Addison-Wesley Professional.

Beaton, A., Gruneberg, M., & Ellis, N. (1995). Retention of foreign vocabulary learned using the keyword method: A ten-year follow-up. *Second Language Research*, *11*(2), 112–120. https://doi.org/10.1177/026765839501100203

Beaton, A., Gruneberg, M., Hyde, C., Shufflebottom, A., & Sykes, R. (2005). Facilitation of receptive and productive foreign vocabulary learning using the keyword method: The role of image quality. *Memory*, *13*(5), 458–471. https://doi.org/10.1080/09658210444000395

Bell, J. M. (2008). *The implementation of the keyword method to increase foreign language vocabulary recall with first year Spanish students*. Defiance College.

Berko, J. (1958). The child's learning of English morphology. WORD, *14*(2–3), 150–177. https://doi.org/10.1080/00437956.1958.11659661

Bevana, N., Kirakowskib, J., & Maissela, J. (1991). *What is usability*. Proceedings of the 4th International Conference on HCI.

Blake, R. J. (2013). *Brave new digital classroom: Technology and foreign language learning*. Georgetown University Press.

Brooke, J. (1996). SUS: a "quick and dirty' usability. *Usability Evaluation in Industry*, *189*.

Brooke, J. (2013). SUS: a retrospective. *Journal of Usability Studies*, *8*(2), 29–40.

Brown, H. D. (2000). *Principles of language learning and teaching* (Vol. 4). Longman New York.

Bull*, S. (1997). Promoting effective learning strategy use in CALL. *Computer Assisted Language Learning*, *10*(1), 3–39.

Bushehrian, O., & Khaldar, R. (2011). An extendable software architecture for personalized e-learning systems. *International Journal of Computer Applications*, *975*, 8887.

Buzzetto-More, N. A. (2007). *Advanced principles of effective e-learning*. Informing Science.

Cameron, L. (2001). *Teaching languages to young learners*. Ernst Klett Sprachen.

Campbell, A., Brown, I., & Weatherford, Y. (2008). *A CALL project with low-level EFL students*. The 3rd World CALL International Conference. Fukuoka, Japan.

Campos, A., Amor, A., & González, M. A. (2004). The importance of the keyword-generation method in keyword mnemonics. *Experimental Psychology*, *51*(2), 125–131. https://doi.org/10.1027/1618-3169.51.2.125

Carney, R. N., & Levin, J. R. (1998). Do mnemonic memories fade as time goes by? Here's looking anew! *Contemporary Educational Psychology*, *23*(3), 276–297. https://doi.org/10.1006/ceps.1998.0970

Carney, R. N., & Levin, J. R. (2008). Conquering mnemonophobia, with help from three practical measures of memory and application. *Teaching of Psychology*, *35*(3), 176–183. https://doi.org/10.1177/009862830803500304

Carter, R., & McCarthy, M. (2014). *Vocabulary and language teaching*. Routledge.

Celce-Murcia, M. (2001). Language teaching approaches: An overview. *Teaching English as a Second or Foreign Language*, *2*(1), 3–10.

Celce-Murcia, M., & McIntosh, L. (1991). *Teaching English as a second or foreign language*.

Cercone, K. (2008). Characteristics of adult learners with implications for online learning design. *AACE Journal*, *16*(2), 137–159.

Chamot, A. U. (2004). Issues in language learning strategy research and teaching. *Electronic Journal of Foreign Language Teaching*, *1*(1), 14–26.

Chamot, A. U. (2005). Language learning strategy instruction: Current issues and research. *Annual Review of Applied Linguistics*, *25*, 112–130.

Chandler, P., & Sweller, J. (1992). The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology*, *62*(2), 233–246. https://doi.org/10.1111/j.2044-8279.1992.tb01017.x

Chang, L. Y.-H. (2007). The influences of group processes on learners' autonomous beliefs and behaviors. *System*, *35*(3), 322–337. https://doi.org/10.1016/j.system.2007.03.001

Chapelle, C. A., Cotos, E., & Lee, J. (2015). Validity arguments for diagnostic assessment using automated writing evaluation. *Language Testing*, *32*(3), 385–405. https://doi.org/10.1177/0265532214565386

Chen, C. (2019). *Learning English as a foreign language in an online interactive environment: A case study in China*.

Chen Hsieh, J. S., Wu, W.-C. V., & Marek, M. W. (2016). Using the flipped classroom to enhance EFL learning. *Computer Assisted Language Learning*, *30*(1–2), 1–21. https://doi.org/10.1080/09588221.2015.1111910

Cheng, C. K. E. (2011). *The role of self-regulated learning in enhancing learning performance*.

Cheng, S.-C., Hwang, W.-Y., Wen, D.-W., Wu, S.-Y., Hsiehe, C.-H., & Chen, C.-Y. (2010). *A mobile and Web system with contextual familiarity and its effect on campus English learning*. 222–224.

Chi, M. T., Glaser, R., & Rees, E. (1981). *Expertise in problem solving*. Pittsburgh Univ PA Learning Research and Development Center.

Chu, H.-N. R. (2008). *Shyness and EFL learning in Taiwan: A study of shy and non-shy college students' use of strategies, foreign language anxiety, motivation, and willingness to communicate*.

Clifford, R., & Granoien, N. (2008). Applications of technology to language acquisition processes. *The Path of Speech Technologies in Computer Assisted Language Learning: From Research Toward Practice*, 25–43.

Clipperton, R. (1994). Best paper by a graduate student award: Explicit vocabulary instruction in French immersion. *Canadian Modern Language Review*, *50*(4), 736–749. https://doi.org/10.3138/cmlr.50.4.736

Coady, J., & Huckin, T. (1997). *Second language vocabulary acquisition: A rationale for pedagogy*. Cambridge University Press.

Cofer, C. N. (1971). Properties of verbal materials and verbal learning. *Woodworth and Schlosberg's Experimental Psychology. New York: Holt, Rinehart & Winston*.

Cohen, A. D. (1987). The use of verbal and imagery mnemonics in second-language vocabulary learning. *Studies in Second Language Acquisition*, *9*(1), 43–61.

Cohen, A. D. (2014). *Strategies in Learning and Using a Second Language*. Routledge.

Coxhead, A., & Nation, P. (2001). The specialised vocabulary of English for academic purposes. *Research Perspectives on English for Academic Purposes*, 252–267.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*(6), 671–684.

Cramer, P. (1981). Imagery and learning: Item recognition and associative recall. *Journal of Educational Psychology*, *73*(2), 164–173. https://doi.org/10.1037/0022-0663.73.2.164

Crompton, H. (2013). A historical overview of m-learning: Toward learner-centered education through the study of recent histories, this chapter provides a historical view of the field of

electronic learning. The chapter begins by explicating the philosophical, pedagogical, and conceptual underpinnings regarding learning, particularly toward learner-centered pedagogies. This is followed by a discussion of the technology, covering the evolution of the hardware/software, its adoption into society, and how these technological advancements have led to today's new affordances for learning. In *Handbook of Mobile Learning* (pp. 41–52). Routledge.

Culbertson, G., Shen, S., Andersen, E., & Jung, M. (2017, February 25). *Have your cake and eat it too*. Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing.

Dang, N. T. (2011). *Exploring CALL options for teaching EFL in Vietnam*.

Dashtestani, R. (2014). Computer literacy of Iranian teachers of English as a foreign language: Challenges and obstacles. *International Journal of Pedagogies and Learning*, *9*(1), 87–100. https://doi.org/10.1080/18334105.2014.11082022

Dashtestani, R. (2016). Moving bravely towards mobile learning: Iranian students' use of mobile devices for learning English as a foreign language. *Computer Assisted Language Learning*, *29*(4), 815–832.

Davoudi, M., & Yousefi, D. (2016). The effect of keyword method on vocabulary retention of senior high school EFL learners in Iran. *Journal of Education and Practice*, *7*(11), 106–113.

DeKeyser, R. M. (2000). The robustness of critical period effects in second language acquisition. *Studies in Second Language Acquisition*, *22*(4), 499–533. https://doi.org/10.1017/s0272263100004022

Delaney, P. F., & Verkoeijen, P. P. J. L. (2009). Rehearsal strategies can enlarge or diminish the spacing effect: Pure versus mixed lists and encoding strategy. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35*(5), 1148–1161. https://doi.org/10.1037/a0016380

Derakhshan, A., & Khodabakhshzadeh, H. (2011). Why CALL why not MALL: an in-depth review of text-message vocabulary learning. *Theory and Practice in Language Studies*, *1*(9). https://doi.org/10.4304/tpls.1.9.1150-1159

Desrochers, A., Wieland, L. D., & Coté, M. (1991). Instructional effects in the use of the mnemonic keyword method for learning German nouns and their grammatical gender. *Applied Cognitive Psychology*, *5*(1), 19–36. https://doi.org/10.1002/acp.2350050103

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). *From game design elements to gamefulness*. Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '11.

Doughty, C. (1982). *Relating second-language acquisition theory to CALL research and application*.

Downes, S. (2010). New technology supporting informal learning. *Journal of Emerging Technologies in Web Intelligence*, *2*(1). https://doi.org/10.4304/jetwi.2.1.27-33

Ducate, L. C., & Lomicka, L. L. (2008). Adventures in the blogosphere: From blog readers to blog writers. *Computer Assisted Language Learning*, *21*(1), 9–28. https://doi.org/10.1080/09588220701865474

Dvorski, D. D. (2007). Installing, configuring, and developing with XAMPP. *Skills Canada*.

Eagle, M., & Leiter, E. (1964). Recall and recognition in intentional and incidental learning. *Journal of Experimental Psychology*, *68*(1), 58–63. https://doi.org/10.1037/h0044655

Ebadi, S., & Ghuchi, K. D. (2018). Investigating the effects of blended learning approach on vocabulary enhancement from EFL learners' perspectives. *Journal on English Language Teaching*, *8*(2), 57–68.

Ebadi, S., Vakilifard, A., & Bahramlou, K. (2018). Learning Persian vocabulary through reading: The effects of noticing and computerized dynamic assessment. *Cogent Education*, *5*(1), 1507176.

Ellis, N. C. (2011). Implicit and explicit SLA and their interface. *Implicit and Explicit Language Learning: Conditions, Processes, and Knowledge in Sla and Bilingualism*, *35*, 47.

Eskandari, M., & Soleimani, H. (2016). The effect of collaborative discovery learning using Moodle on the learning of conditional sentences by Iranian EFL learners. *Theory and Practice in Language Studies*, *6*(1), 153. https://doi.org/10.17507/tpls.0601.20

Esmaeili, Z., & Shahrokhi, M. (2020). The impact of Memrise application on Iranian EFL learners' collocation learning and retention. *International Journal of Language Education*, *4*(2), 222–233.

Eysenck, M. W. (2001). *Principles of cognitive psychology*. Psychology Press.

Fan, S. (2011). *Significance of the web as a learning resource in an Australian university context*. University of Tasmania.

Fang, C. F., & Sing, L. C. (2009). Collaborative learning using service-oriented architecture: A framework design. *Knowledge-Based Systems*, *22*(4), 271–274. https://doi.org/10.1016/j.knosys.2009.01.003

Farivar, A., & Rahimi, A. (2015). The impact of CALL on Iranian EFL learners' autonomy. *Procedia-Social and Behavioral Sciences*, *192*, 644–649.

Fleissner, A., Mischke, W., Rautenhaus, H., Rettin, J., & Sattler, F. (1991). *How to teach a language by computer and yet promote the use of learning strategies*. 55–61.

Folse, K. S. (2012). Myths about second language vocabulary learning. In *The Encyclopedia of Applied Linguistics*. Blackwell Publishing Ltd.

Freiermuth, M. R. (2002). Connecting with computer science students by building bridges. *Simulation & Gaming*, *33*(3), 299–315. https://doi.org/10.1177/104687810203300305

Fritz, C. O., Morris, P. E., Acton, M., Voelkel, A. R., & Etkind, R. (2007). Comparing and combining retrieval practice and the keyword mnemonic for foreign vocabulary learning. *Applied Cognitive Psychology*, *21*(4), 499–526. https://doi.org/10.1002/acp.1287

Gallegos, C., & Nakashima, H. (2018). Mobile devices: A distraction, or a useful tool to engage nursing students? *Journal of Nursing Education*, *57*(3), 170–173.

Gamper, J., & Knapp, J. (2002). A review of intelligent CALL systems. *Computer Assisted Language Learning*, *15*(4), 329–342. https://doi.org/10.1076/call.15.4.329.8270

Gao, M. (2017). *Measuring the usability of home healthcare devices* [PhD Thesis].

Garrett, J. J. (2010). *The elements of user experience: User-centered design for the web and beyond*. Pearson Education.

Gass, S. (1999). Discussion: Incidental vocabulary learning. *Studies in Second Language Acquisition*, 319–333.

Gentner, D., Loewenstein, J., & Thompson, L. (2003). Learning and transfer: A general role for analogical encoding. *Journal of Educational Psychology*, *95*(2), 393–408. https://doi.org/10.1037/0022-0663.95.2.393

Ghobadi, S., & Taki, S. (2018). Effects of Telegram stickers on English vocabulary learning: Focus on Iranian EFL learners. *Research in English Language Pedagogy*, *6*(1), 139–158.

Gillespie, J. H., & Gray, B. (1992). HyperCard and the development of translation and vocabulary skills. *Computer Assisted Language Learning*, *5*(1–2), 3–11.

Gillespie, J., & McKee, J. (1999). Does it fit and does it make any difference? Integrating CALL into the curriculum. *Computer Assisted Language Learning*, *12*(5), 441–455. https://doi.org/10.1076/call.12.5.441.5692

Godwin-Jones, R. (2010). Emerging technologies from memory places to spaces algorithms: Approaches to second language vocabulary learning. *Language Learning & Technology, 4*.

Godwin-Jones, R. (2011). Mobile apps for language learning. *Language Learning & Technology*, *15*(2), 2–11.

González López, P. A. (2017). *Vclass, a virtual homework strategy to reinforce and improve the English communicative skills of EFL young learners*.

Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach*. Longman/Addison Wesley Longman.

Green, J. M., & Oxford, R. (1995). A closer look at learning strategies, L2 proficiency, and gender. *TESOL Quarterly*, *29*(2), 261. https://doi.org/10.2307/3587625

Greenwood, S. C. (2002). Making words matter: Vocabulary study in the content areas. *The Clearing House*, *75*(5), 258–263.

Grgurović, M., Chapelle, C. A., & Shelley, M. C. (2013). A meta-analysis of effectiveness studies on computer technology-supported language learning. *ReCALL*, *25*(2), 165–198. https://doi.org/10.1017/s0958344013000013

Gruneberg, M. (1987). *Linkword French, German, Spanish, Italian, Greek, Japanese, Russian, Dutch, Portuguese, Hebrew, Welsh*.

Gu, P. Y. (2002). Gender, academic major, and vocabulary learning strategies of Chinese EFL learners. *RELC Journal*, *33*(1), 35–54.

Gu, P. Y. (2003). Vocabulary learning in a second language: Person, task, context and strategies. *TESL-EJ*, *7*(2), 1–25.

Gu, P. Y. (2018). Validation of an online questionnaire of vocabulary learning strategies for ESL learners. *Studies in Second Language Learning and Teaching*, *8*(2), 325–350.

Gu, S. (2017). *Effects of interaction process on EFL development*. Springer Singapore.

Gu, Y. (2012). Vocabulary learning strategies. *The Encyclopedia of Applied Linguistics*, 1–7.

Hamada, M., & Koda, K. (2008). Influence of first language orthographic experience on second language decoding and word learning. *Language Learning*, *58*(1), 1–31. https://doi.org/10.1111/j.1467-9922.2007.00433.x

Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). *Does gamification work? —A literature review of empirical studies on gamification*. 2014 47th Hawaii International Conference on System Sciences.

Han, T., & Keskin, F. (2016). Using a mobile application (WhatsApp) to reduce EFL speaking anxiety. *Gist: Education and Learning Research Journal*, *12*, 29–50.

Harrison, R., Flood, D., & Duce, D. (2013). Usability of mobile applications: Literature review and rationale for a new usability model. *Journal of Interaction Science*, *1*(1), 1. https://doi.org/10.1186/2194-0827-1-1

Hartson, R. (2003). Cognitive, physical, sensory, and functional affordances in interaction design. *Behaviour & Information Technology*, *22*(5), 315–338. https://doi.org/10.1080/01449290310001592587

Haryati, H. (2017). *EFL students' perspectives of applying CALL through project-based learning*. UICELL Conference Proceeding.

Hashemian, M., & Fadaei, B. (2013). The effect of lexical glossing types on Persian L2 learners' reading and listening. *Procedia-Social and Behavioral Sciences*, *70*, 490–500.

Hashemifardnia, A., Namaziandost, E., & Rahimi Esfahani, F. (2018). The effect of using WhatsApp on Iranian EFL learners' vocabulary learning. *Journal of Applied Linguistics and Language Research*, *5*(3), 256–267.

Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, *66*(2), 99–136. https://doi.org/10.3102/00346543066002099

Hazaea, A. N., & Alzubi, A. A. (2016). The effectiveness of using mobile on EFL learners' reading practices in Najran University. *English Language Teaching*, *9*(5), 8. https://doi.org/10.5539/elt.v9n5p8

Healey, D. (1999). Theory and research: Autonomy in language learning. *CALL Environments: Research, Practice, and Critical Issues*.

Herrera Mosquera, L. (2017). Impact of implementing a virtual learning environment (VLE) in the EFL classroom. *Íkala, Revista de Lenguaje y Cultura*, *22*(3), 479–498. https://doi.org/10.17533/udea.ikala.v22n03a07

Hirschel, R., & Fritz, E. (2013). Learning vocabulary: CALL program versus vocabulary notebook. *System*, *41*(3), 639–653.

Hogben, D., & Lawson, M. J. (1994). Keyword and multiple elaboration strategies for vocabulary acquisition in foreign language learning. *Contemporary Educational Psychology*, *19*(3), 367–376. https://doi.org/10.1006/ceps.1994.1027

Horst, M., Cobb, T., & Nicolae, I. (2005). Expanding academic vocabulary with an interactive on-line database. *Language Learning & Technology*, *9*(2), 90–110.

HTML & CSS. W3C official website. (2020).

Hu, Y., Peng, L., & Chi, C. (2003). Design technology of three-tier architecture on web application based on .NET[j]. *Computer Engineering*, *8*.

Huang, H.-T. D., & Hung, S.-T. A. (2013). Exploring the utility of a video-based online EFL discussion forum. *British Journal of Educational Technology*, *44*(3), E90–E94. https://doi.org/10.1111/j.1467-8535.2012.01373.x

Huang, Y. (2014). *Empirical analysis on factors impacting mobile learning acceptance in higher engineering education*.

Hubbard, P. (2013). Learner training for effective use of CALL. In *New Perspectives on CALL for Second Language Classrooms* (pp. 57–80). Routledge.

Huckin, T. (1995). *Second language reading and vocabulary learning.*

Hulstijn, J. (1996). Mnemonic methods in foreign language vocabulary learning: Theoretical considerations and pedagogical implications. In J. Coady & T. Huckin (Eds.), *Second Language Vocabulary Acquisition: A Rationale for Pedagogy* (pp. 203–224). Cambridge University Press; Cambridge Core. https://doi.org/10.1017/CBO9781139524643.015

Hulstijn, J. H. (1992). *Retention of inferred and given word meanings: Experiments in incidental vocabulary learning*. Palgrave Macmillan UK.

Hung, M.-L., Chou, C., Chen, C.-H., & Own, Z.-Y. (2010). Learner readiness for online learning: Scale development and student perceptions. *Computers & Education*, *55*(3), 1080–1090. https://doi.org/10.1016/j.compedu.2010.05.004

Hunt, A., & Beglar, D. (1998). *Current research and practice in teaching vocabulary. The language teacher*.

Hwang, J. (2018). *The use of a mobile instant messaging (MIM) application for English interaction in the Korean EFL context*.

Introducing JSON. JSON official website. (2020).

Iqbal, F. (2015). *Understanding user interaction in a video game by using eye tracking and facial expressions analysis*.

ISO 9241-11:2018: Ergonomics of human-system interaction—Part 11: Usability: Definitions and concepts. (2018).

Ivie, S. D. (1998). Ausubel's learning theory: An approach to teaching higher order thinking skills. *The High School Journal*, *82*(1), 35–42.

Jahangard, A. (2007). Evaluation of the EFL materials taught at Iranian high schools. *The Asian EFL Journal*, *9*(2), 130–150.

Jeong, E., & Kim, D. (2007). *Definitions, key characteristics, and generations of mobile games*. IGI Global.

Joseph, S. R. H., & Uther, M. (2009). Mobile devices for language learning: Multimedia approaches. *Research and Practice in Technology Enhanced Learning*, *04*(01), 7–32. https://doi.org/10.1142/s179320680900060x

Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The Expertise Reversal Effect. *Educational Psychologist*, *38*(1), 23–31. https://doi.org/10.1207/S15326985EP3801_4

Kavani, R., & Amjadiparvar, A. (2018). The effect of strategy-based instruction on motivation, self-regulated learning, and reading comprehension ability of Iranian EFL learning. *Cogent Education*, *5*(1), 1556196.

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology*, *20*(1), n1.

Kelly, P. (1990). Guessing: No substitute for systematic learning of lexis. *System*, *18*(2), 199–207. https://doi.org/10.1016/0346-251x(90)90054-9

Khabiri, M., & Khatibi, M. B. (2013). Mobile-assisted language learning: Practices among Iranian EFL learners. *European Online Journal of Natural and Social Sciences*, *2*(2s), pp-176.

Khoshsima, H., & Sayadi, F. (2016). The effect of virtual language learning method on writing ability of Iranian intermediate EFL learners. *Advances in Language and Literary Studies*, *7*(2), 192–202.

Kilickaya, F., & Krajka, J. (2010). Comparative usefulness of online and traditional vocabulary learning. *Turkish Online Journal of Educational Technology-TOJET*, *9*(2), 55–63.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Klopfer, E., & Squire, K. (2007). Environmental detectives—The development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development*, *56*(2), 203–228. https://doi.org/10.1007/s11423-007-9037-6

Koole, M. (2006). *The framework for the rational analysis of mobile education (FRAME) model: An evaluation of mobile devices for distance education*.

Koole, M. (2009). A model for framing mobile learning. *Mobile Learning: Transforming the Delivery of Education and Training*, *1*(2), 25–47.

Koole, M., & Ally, M. (2006). *Framework for the rational analysis of mobile education (FRAME) model: Revising the ABCs of educational practices*. 216–216.

Kortum, P., & Sorber, M. (2015). Measuring the usability of mobile applications for phones and tablets. *International Journal of Human-Computer Interaction*, *31*(8), 518–529.

Kukulska-Hulme, A. (2009). Will mobile learning change language learning? *ReCALL, 21*(2), 157–165. https://doi.org/10.1017/s0958344009000202

Kuru Gönen, S. İ. (2019). A qualitative study on a situated experience of technology integration: Reflections from pre-service teachers and students. *Computer Assisted Language Learning, 32*(3), 163–189.

Kyndt, E., Dochy, F., Struyven, K., & Cascallar, E. (2010). The perception of workload and task complexity and its influence on students' approaches to learning: A study in higher education. *European Journal of Psychology of Education, 26*(3), 393–415. https://doi.org/10.1007/s10212-010-0053-2

Lai, C., & Gu, M. (2011). Self-regulated out-of-class language learning with technology. *Computer Assisted Language Learning*, *24*(4), 317–335. https://doi.org/10.1080/09588221.2011.568417

Langan, D., Schott, N., Wykes, T., Szeto, J., Kolpin, S., Lopez, C., & Smith, N. (2016). Students' use of personal technologies in the university classroom: Analysing the perceptions of the digital generation. *Technology, Pedagogy and Education*, *25*(1), 101–117.

Laufer, B. (2003). Vocabulary acquisition in a second language: Do learners really acquire most vocabulary by reading? Some empirical evidence. *Canadian Modern Language Review, 59*(4), 567–587. https://doi.org/10.3138/cmlr.59.4.567

Laurie, B., & Laurie, P. (2002). *Apache the definitive guide 3rd edition*. Sebastopol, O'Reilly Media.

Lawson, M. J., & Hogben, D. (1996). The vocabulary-learning strategies of foreign-language students. *Language Learning, 46*(1), 101–135. https://doi.org/10.1111/j.1467-1770.1996.tb00642.x

Lawson, M. J., & Hogben, D. (1998). Learning and recall of foreign-language vocabulary: Effects of a keyword strategy for immediate and delayed recall. *Learning and Instruction, 8*(2), 179–194. https://doi.org/10.1016/s0959-4752(97)00016-9

Lee, H. W., Lim, K. Y., & Grabowski, B. L. (2010). Improving self-regulation, learning strategy use, and achievement with metacognitive feedback. *Educational Technology Research and Development*, *58*(6), 629–648. https://doi.org/10.1007/s11423-010-9153-6

Leech, D. H. (1991). Teaching and learning vocabulary by ISP Nation. New York: Newbury House, 1990. 275 pp. *Issues in Applied Linguistics*, *2*(1).

Lerdorf, R., Tatroe, K., & MacIntyre, P. (2006). *Programming PHP*. O'Reilly Media, Inc.

Levin, J. R. (1993). Mnemonic strategies and classroom learning: A twenty-year report card. *The Elementary School Journal*, *94*(2), 235–244. https://doi.org/10.1086/461763

Levin, J. R., Davidson, R. E., Wolff, P., & Citron, M. (1973). A comparison of induced imagery and sentence strategies in children's paired-associate learning. *Journal of Educational Psychology*, *64*(3), 306–309. https://doi.org/10.1037/h0034385

Lewis, J. J. R., & Sauro, J. (2017). Revisiting the Factor Structure of the System Usability Scale. *Journal of Usability Studies*, *12*(4).

Lewis, J. R. (2018). The system usability scale: Past, present, and future. *International Journal of Human–Computer Interaction*, *34*(7), 577–590.

Lewis, J. R., & Sauro, J. (2009). *The factor structure of the system usability scale*. 94–103.

Lewis, J. R., Utesch, B. S., & Maher, D. E. (2015). Measuring perceived usability: The SUS, UMUX-LITE, and AltUsability. *International Journal of Human-Computer Interaction*, *31*(8), 496–505. https://doi.org/10.1080/10447318.2015.1064654

Liao, H.-C. (2016). Enhancing the grammatical accuracy of EFL writing by using an AWE-assisted process approach. *System*, *62*, 77–92. https://doi.org/10.1016/j.system.2016.02.007

Lim, K.-M., & Zhong Shen, H. U. I. (2006). Integration of computers into an EFL reading classroom. *ReCALL*, *18*(2), 212–229. https://doi.org/10.1017/s0958344006000528

Lim, Y.-K., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *15*(2), 1–27. https://doi.org/10.1145/1375761.1375762

Lin, C.-H., Warschauer, M., & Blake, R. (2016). *Language learning through social networks survey* (PsycTESTS Dataset). American Psychological Association (APA).

Linse, C. T., & Nunan, D. (2005). *Practical English language teaching: Young learners/by Caroline T. Linse; David Nunan, series editor. McGraw-Hill, New York.*

Liu, D. T., & Xu, X. W. (2001). A review of web-based product data management systems. *Computers in Industry*, *44*(3), 251–262.

Liu, M. hui. (2012). Discussing teaching videocases online: Perspectives of preservice and inservice EFL teachers in Taiwan. *Computers & Education*, *59*(1), 120–133. https://doi.org/10.1016/j.compedu.2011.09.004

Liu, P. L. (2014). Using eye tracking to understand the responses of learners to vocabulary learning strategy instruction and use. *Computer Assisted Language Learning*, *27*(4), 330–343.

Lizzio, A., Wilson, K., & Simons, R. (2002). University students' perceptions of the learning environment and academic outcomes: Implications for theory and practice. *Studies in Higher Education*, *27*(1), 27–52. https://doi.org/10.1080/03075070120099359

Lomicka, L. L. (1998). 'To gloss or not to gloss': An investigation of reading comprehension online. *Language Learning & Technology*, *1*(2), 41–50.

Lu, J., Throssell, P., & Jiang, H. (2013). Exploring the application of computer-assisted English learning in a Chinese mainland context: Based on students' attitudes and behaviours. *International Journal of English Linguistics*, *3*(3). https://doi.org/10.5539/ijel.v3n3p31

Lu, M. (2008). Effectiveness of vocabulary learning via mobile phone. *Journal of Computer Assisted Learning*, *24*(6), 515–525.

Ma, Q. (2013). Computer assisted vocabulary learning: Framework and tracking users' data. *CALICO Journal*, *30*, 230–243.

Ma, Q. (2014). A contextualised study of EFL learners' vocabulary learning approaches: Framework, learner approach and degree of success. *Journal of Asia TEFL*, *11*(3).

Ma, Q. (2017). *Technologies for teaching and learning L2 vocabulary*. Wiley.

Macaro, E. (2006). Strategies for language learning and for language use: Revising the theoretical framework. *The Modern Language Journal*, *90*(3), 320–337. https://doi.org/10.1111/j.1540-4781.2006.00425.x

Magnussen, S., & Helstrup, T. (2007). *Everyday memory*. Psychology Press.

Maniar, N. (2007b). M-learning to teach university students. In C. Montgomerie & J. Seale (Eds.), *Proceedings of EdMedia + Innovate Learning 2007* (pp. 881–887). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/p/25485

Manis, M. (1966). *Cognitive processes*. Wadsworth Publishing Company.

Marty, F. (1981). Reflections on the use of computers in second-language acqusition—I. *System*, *9*(2), 85–98. https://doi.org/10.1016/0346-251x(81)90023-3

Marzban, A. (2011). Improvement of reading comprehension through computer-assisted language learning in Iranian intermediate EFL students. *Procedia Computer Science*, *3*, 3–10.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (1986). Direct vs. Mnemonic instruction: Relative benefits for exceptional learners. *The Journal of Special Education*, *20*(3), 299–308. https://doi.org/10.1177/002246698602000304

Mayer, R. E. (2005). *The Cambridge handbook of multimedia learning*. Cambridge University Press.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43–52. https://doi.org/10.1207/s15326985ep3801_6

Mazman, S. G., & Usluel, Y. K. (2010). Modeling educational usage of Facebook. *Computers & Education*, *55*(2), 444–453. https://doi.org/10.1016/j.compedu.2010.02.008

McCarthy, J., & Wright, P. (2004). Technology as experience. *Interactions*, *11*(5), 42–43. https://doi.org/10.1145/1015530.1015549

McCrostie, J. (2007). Examining learner vocabulary notebooks. *ELT Journal*, *61*(3), 246–255. https://doi.org/10.1093/elt/ccm032

McDaniel, M. A., Pressley, M., & Dunay, P. K. (1987). Long-term retention of vocabulary after keyword and context learning. *Journal of Educational Psychology, 79*(1), 87–89. https://doi.org/10.1037/0022-0663.79.1.87

McLaughlin, B., Rossman, T., & McLeod, B. (1983). Second language learning: An information-processing perspective 1. *Language Learning, 33*(2), 135–158.

Memory | definition of memory by Merriam-Webster. (2020). Memory | Definition of Memory by Merriam-Webster. https://www.merriam-webster.com/dictionary/memory#:~:text=1%20%3A%20the%20power%20or%20process,memory%20as%20he%20grew%20older.

Mergel, B. (1998). *Instructional design and learning theory*. Citeseer.

Miangah, T. M., & Nezarat, A. (2012). Mobile-assisted language learning. *International Journal of Distributed and Parallel Systems, 3*(1), 309.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81–97. https://doi.org/10.1037/h0043158

Miller, L., & Wu, J. G. (2018). From structured to unstructured learning via a technology-mediated learning framework. *EAI Endorsed Transactions on E-Learning, 5*(17).

Mirzaei, S. (2016). *Evaluating efficacy and usability of mobile devices for learning new vocabulary items* (Graduate Diploma dissertation, Flinders University, School of Computer Science, Engineering and Mathematics).

Mirzaei, S., & Hayati, A. F. (2018). Effects of the computer mediated communication interaction on vocabulary improvement. *Telkomnika, 16*(5), 2217–2225.

Mirzaei, S., Lewis, T. W., Wyra, M., & Wilkinson, B. (2020a). *Usability testing of VLASTWA: A vocabulary learning and strategy teaching web-app*. OzCHI ’20: 32nd Australian Conference on Human-Computer Interaction, Sydney, Australia, December 2020.

Mirzaei, S., Lewis, T. W., Wyra, M., & Wilkinson, B. (2020b). VLASTWA: A vocabulary learning and strategy teaching web-app. *CALL for Widening Participation: Short Papers from EuroCALL 2020*, 240.

Mirzaei, S., Wilkinson, B., & Wyra, M. (2018, December). *Usability testing of VLASTA: A vocabulary learning and strategy teaching app*. 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE).

Miyazoe, T., & Anderson, T. (2010). Learning outcomes and students' perceptions of online writing: Simultaneous implementation of a forum, blog, and wiki in an EFL blended learning setting. *System, 38*(2), 185–199. https://doi.org/10.1016/j.system.2010.03.006

Morino, A., Lopez, E., & Ono, Y. (2017). *Effects of a digital storytelling project on Japanese EFL learners' CALL attitudes and awareness of CALL tasks*. 367–373.

Morrison, G. R., Ross, S. M., Kemp, J. E., & Kalman, H. K. (2007). Learner and contextual analysis. *Designing Effective Instruction (5th Ed.). Hoboken, NJ: John Wiley & Sons*.

Moulden, H. (1986). The computer as an aid to learning to learn English: A project and one feasibility study'. *Mélanges Pédagogiques, 17*.

Muhamad, M., & Kiely, R. (2018). Understanding teachers' pedagogical knowledge in ESL vocabulary teaching. *Journal of Arts and Humanities, 7*(1), 36–47.

Munoz, C. (2008). Symmetries and asymmetries of age effects in naturalistic and instructed L2 learning. *Applied Linguistics*, *29*(4), 578–596. https://doi.org/10.1093/applin/amm056

Nagy, W., Scott, J., Kamil, M. L., Mosenthal, P. B., Pearson, P. D., & Barr, R. (2000). Vocabulary processes. *Handbook of Reading Research, 3*.

Namaziandost, E., Alekasir, S., & Tilwani, S. A. (2021). An account of EFL learners' vocabulary learning in a mobile-assisted language environment: The case of Rosetta Stone application. *Computer-Assisted Language Learning*, *22*(1), 80–110.

Nash, H., & Snowling, M. (2006). Teaching new words to children with poor existing vocabulary knowledge: A controlled evaluation of the definition and context methods. *International*

Journal of Language & Communication Disorders, *41*(3), 335–354. https://doi.org/10.1080/13682820600602295

Nation, I. S. P. (1982). Beginning to learn foreign vocabulary: A review of the research. *RELC Journal*, *13*(1), 14–36.

Nation, I. S. P. (1993). Using dictionaries to estimate vocabulary size: Essential, but rarely followed, procedures. *Language Testing*, *10*(1), 27–40. https://doi.org/10.1177/026553229301000102

Nation, I. S. P. (2001). *Learning vocabulary in another language*. Cambridge University Press.

Nation, I. S. P. (2002). *Best practice in vocabulary teaching and learning*. Cambridge University Press.

Nation, I. S. P., & Webb, S. A. (2011). *Researching and analyzing vocabulary*. Heinle, Cengage Learning Boston, MA.

Navehebrahim, M. (2012). *Retracted: An investigation on pronunciation of language learners of English in Persian background: Deviation forms from the target language norms*.

Nejati, E., Jahangiri, A., & Salehi, M. R. (2018). The effect of using computer-assisted language learning (CALL) on Iranian EFL learners' vocabulary learning: An experimental study. *Cypriot Journal of Educational Sciences*, *13*(2), 351–362.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199–218.

Nielsen, J. (1994). *Usability engineering Elsevier*.

Nim Park, C., & Son, J.-B. (2009). Implementing computer-assisted language learning in the EFL classroom: Teachers' perceptions and perspectives. *International Journal of Pedagogies and Learning*, *5*(2), 80–101. https://doi.org/10.5172/ijpl.5.2.80

Nissinen, T. (2015). User experience prototyping–a literature review. *University of Oulu, Oulu*.

Norman, D. (2016). The definition of user experience (UX). Nielsen Norman group. *Recuperado De: Https://Www. Nngroup. Com/Articles/Definition-Userexperience/, Consultado El*, *15*(12), 2016.

Nunan, D. (1991). *Language teaching methodology: A textbook for teachers*. Prentice hall.

Ortega, L. (2014). *Understanding second language acquisition*. Routledge.

Ott, C. E., Butler, D. C., Blake, R. S., & Ball, J. P. (1973). The effect of interactive-image elaboration on the acquisition of foreign language vocabulary. *Language Learning*, *23*(2), 197–206. https://doi.org/10.1111/j.1467-1770.1973.tb00655.x

Oxford, R., & Burry-Stock, J. A. (1995). Assessing the use of language learning strategies worldwide with the ESL/EFL version of the strategy inventory for language learning (SILL). *System*, *23*(1), 1–23. https://doi.org/10.1016/0346-251x(94)00047-a

Oxford, R. L. (1990a). Language learning strategies. *New York*, *3*.

Oxford, R. L. (1990b). *Language learning strategies-What every teacher should know*. Heinle & Heinle.

Oxford, R. L. (1999). Relationships between second language learning strategies and language proficiency in the context of learner autonomy and self-regulation. *Revista Canaria de Estudios Ingleses*, *38*(1), 108–126.

Oxland, K. (2004). *Gameplay and design*. Pearson Education.

Paas, F., & Sweller, J. (2014). Implications of cognitive load theory for multimedia learning. *The Cambridge Handbook of Multimedia Learning*, *27*, 27–42.

Paas, F., & Van Merriënboer, J. J. G. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review*, *6*(4), 351–371. https://doi.org/10.1007/bf02213420

Paivio, A. (1971). *Imagery and verbal processes. New York, NY: Holt, Rinheart & Winston. Paivio, A. 1986. Mental representation: A dual-coding approach*. New York, NY: Oxford University Press.

Paivio, A., & Desrochers, A. (1979). Effects of an imagery mnemonic on second language recall and comprehension. *Canadian Journal of Psychology/Revue Canadienne De Psychologie*, *33*(1), 17.

Paivio, A., & Desrochers, A. (1981). Mnemonic techniques in second-language learning. *Journal of Educational Psychology*, *73*(6), 780.

Palalas, A. (2011). *Mobile-assisted language learning: Designing for your students*. Research-publishing.net.

Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *International Review of Research in Open and Distributed Learning*, *12*(2), 78–102.

Parmaxi, A., Zaphiris, P., Papadima-Sophocleous, S., & Ioannou, A. (2013). Mapping the landscape of computer-assisted language learning: An inventory of research. *Interactive Technology and Smart Education*, *10*(4), 252–269. https://doi.org/10.1108/itse-02-2013-0004

Patchin, C. (2019). *Exercise design and vocabulary learning in tutorial CALL: the effects of image features and combinations on attention to written forms*. Arizona State University.

Pavičić Takač, V. (2008). *Vocabulary learning strategies and foreign language acquisition*. Multilingual Matters.

Peterson, M. (2011). Towards a research agenda for the use of three- dimensional virtual worlds in language learning. *CALICO Journal*, *29*(1), 67–80. https://doi.org/10.11139/cj.29.1.67-80

PhpStorm: The lightning-smart IDE for PHP programming by JetBrains. (2020). PhpStorm: The Lightning-Smart IDE for PHP Programming by JetBrains. https://www.jetbrains.com/phpstorm/

Ping, A. M., Baranovich, D.-L., Manueli, M. K., & Siraj, S. (2015). Promoting self-regulation in vocabulary learning among Chinese EFL learners: A needs analysis. *The Asia-Pacific Education Researcher*, *24*(1), 137–146.

Pirasteh, P. (2014). The effectiveness of computer-assisted language learning (CALL) on learning grammar by Iranian EFL learners. *Procedia-Social and Behavioral Sciences*, *98*, 1422–1427.

Piribabadi, A., & Rahmany, R. (2014). The effect of the keyword method and word-list method instruction on ESP vocabulary learning. *Journal of Language Teaching & Research*, *5*(5).

Pressley, M. (1977). Imagery and children's learning: Putting the picture in developmental perspective. *Review of Educational Research*, *47*(4), 585–622. https://doi.org/10.3102/00346543047004585

Pressley, M. (1990). *Cognitive strategy instruction that really improves children's academic performance*. Brookline Books.

Pressley, M. (1977a). Children's use of the keyword method to learn simple Spanish vocabulary words. *Journal of Educational Psychology*, *69*(5), 465.

Pressley, M., & Dennis-Rounds, J. (1980a). Transfer of a mnemonic keyword strategy at two age levels. *Journal of Educational Psychology*, *72*(4), 575–582. https://doi.org/10.1037/0022-0663.72.4.575

Pressley, M., & Hilden, K. (2006). Cognitive strategies: Production deficiencies and successful strategy instruction everywhere. *D. Kuhn & R. Siegler (Eds.), Handbook of Child Psychology*, *2*.

Pressley, M., Levin, J. R., Hall, J. W., Miller, G. E., & Berry, J. K. (1980b). The keyword method and foreign word acquisition. *Journal of Experimental Psychology: Human Learning and Memory*, *6*(2), 163.

Pressley, M., Levin, J. R., Kuiper, N. A., Bryant, S. L., & Michener, S. (1982). Mnemonic versus nonmnemonic vocabulary-learning strategies: Additional comparisons. *Journal of Educational Psychology*, *74*(5), 693.

Pressley, M., Levin, J. R., & McCormick, C. B. (1980). Young children's learning of foreign language vocabulary: A sentence variation of the keyword method. *Contemporary Educational Psychology*, *5*(1), 22–29. https://doi.org/10.1016/0361-476x(80)90024-7

Pressley, M., Levin, J. R., & Miller, G. E. (1981). How does the keyword method affect vocabulary comprehension and usage? *Reading Research Quarterly*, *16*(2), 213. https://doi.org/10.2307/747556

Pressley, M., Levin, J. R., Nakamura, G. V., Hope, D. J., Bispo, J. G., & Toye, A. R. (1980c). The keyword method of foreign vocabulary learning: An investigation of its generalizability. *Journal of Applied Psychology*, *65*(6), 635.

Puentedura, R. (2010). *SAMR and TPCK: Intro to advanced practice*.

Rahimi, M., & Tavakoli, M. (2015). The effectiveness of CALL in helping Persian L2 learners produce the English vowel/ɒ. *GEMA Online® Journal of Language Studies*, *15*(3).

Ramirez, A. O. (2000). Three-tier architecture. *Linux Journal*, *2000*(75es), 7-es.

Raugh, M. R., & Atkinson, R. C. (1975). A mnemonic method for learning a second-language vocabulary. *Journal of Educational Psychology*, *67*(1), 1–16. https://doi.org/10.1037/h0078665

Reed, S. K. (2006). Cognitive architectures for multimedia learning. *Educational Psychologist*, *41*(2), 87–98. https://doi.org/10.1207/s15326985ep4102_2

Richards, C. (2005). The design of effective ICT-supported learning activities: Exemplary models, changing requirements, and new possibilities. *Language Learning & Technology*, *9*(1), 60–79.

Richards, J. C. (1976). The role of vocabulary teaching. *TESOL Quarterly*, *10*(1), 77. https://doi.org/10.2307/3585941

Robertson, I. W. (2018). *Subjective usability evaluation: A comparison of four methods*.

Robey, D. (1996). Research commentary: Diversity in information systems research: Threat, promise, and responsibility. *Information Systems Research, 7*(4), 400–408. https://doi.org/10.1287/isre.7.4.400

Rodriguez, M., & Sadoski, M. (2000). Effects of rote, context, keyword, and context/keyword methods on retention of vocabulary in EFL classrooms. *Language Learning*, *50*(2), 385–412.

Rogers, Y., Sharp, H., & Preece, J. (2011). *Interaction design: Beyond human-computer interaction*. John Wiley & Sons.

Roto, V., Vermeeren, A., Väänänen-Vainio-Mattila, K., & Law, E. (2011). *User experience evaluation – which method to choose?* Springer Berlin Heidelberg.

Rubin, J. (1975). What the 'good language learner' can teach us. *TESOL Quarterly*, *9*(1), 41. https://doi.org/10.2307/3586011

Rubio, F., & Thoms, J. J. (2014). *Hybrid language teaching and learning: Exploring theoretical, pedagogical and curricular issues*.

Sadeghi, K., & Dousti, M. (2013). The effect of length of exposure to CALL technology on young Iranian EFL learners' grammar gain. *English Language Teaching*, *6*(2), 14–26.

Sagarra, N., & Alba, M. (2006). The key is in the keyword: L2 vocabulary learning methods with beginning learners of Spanish. *The Modern Language Journal*, *90*(2), 228–243. https://doi.org/10.1111/j.1540-4781.2006.00394.x

Salen, K., Tekinbaş, K. S., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. MIT press.

Salonen, P., Vauras, M., & Efklides, A. (2005). Social interaction—What can it tell us about metacognition and coregulation in learning? *European Psychologist*, *10*(3), 199–208. https://doi.org/10.1027/1016-9040.10.3.199

Schmitt, N. (1997). Vocabulary learning strategies. *Vocabulary: Description, Acquisition and Pedagogy, 199227*.

Schmitt, N. (2008). Review article: Instructed second language vocabulary learning. *Language Teaching Research*, *12*(3), 329–363. https://doi.org/10.1177/1362168808089921

Schmitt, N., & McCarthy, M. (1997). *Second language vocabulary: Description, acquisition and pedagogy*.

Schmitt, N., & Schmitt, D. (2020). *Vocabulary in language teaching*. Cambridge University Press.

Sedaghatkar, M. (2017). The effect of computer-assisted language learning (CALL) on immediate and delayed retention of vocabularies in general English course. *International Journal of Applied Linguistics and English Literature*, *7*(1), 231–238.

Seufert, T. (2018). The interplay between self-regulation in learning and cognitive load. *Educational Research Review*, *24*, 116–129.

Shahlou, P., & Izadpanah, S. (2016). The study of relationship between EFL teacher's teaching context and their attitudes towards computer assisted language learning. *The Social Sciences*, *11*(29), 7018–7024.

Shams, I. E. (2013). Hybrid learning and Iranian EFL learners' autonomy in vocabulary learning. *Procedia-Social and Behavioral Sciences*, *93*, 1587–1592.

Shapiro, A. M., & Waters, D. L. (2005). An investigation of the cognitive processes underlying the keyword method of foreign vocabulary learning. *Language Teaching Research*, *9*(2), 129–146. https://doi.org/10.1191/1362168805lr151oa

Sheldon, L. (2020). *The multiplayer classroom: Designing coursework as a game*. CRC Press.

Shin, H.-J., & Son, J.-B. (2007). EFL teachers' perceptions and perspectives on Internet-assisted language teaching. *Computer-Assisted Language Learning Electronic Journal (CALL-EJ)*, *8*(2).

Shokrpour, N., Mirshekari, Z., & Moslehi, S. (2019). Learning vocabulary electronically: Does computer assisted language learning (CALL) instruction have any impacts on Iranian EFL learners? *Cogent Education*, *6*(1), 1702827.

Siegel, J., & Shaughnessy, M. F. (1994). Educating for understanding. *Phi Delta Kappan*, *75*(7), 563–566.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*.

Singleton, D. (1995). Introduction: A critical look at the critical period hypothesis in second language acquisition research. *The Age Factor in Second Language Acquisition*, 1–29.

Smith, K., & Craig, H. (2013). Enhancing the autonomous use of CALL: a new curriculum model in EFL. *CALICO Journal*, *30*(2), 252–278. https://doi.org/10.11139/cj.30.2.252-278

Smith, M. K. (1999, 2008). *'Informal learning', The encyclopedia of pedagogy and informal education*.

Sommer, S., & Gruneberg, M. (2002). The use of Linkword language computer courses in a classroom situation: A case study at Rugby school. *The Language Learning Journal*, *26*(1), 48–53. https://doi.org/10.1080/09571730285200231

Son, J.-B. (2018). Technology in English as a foreign language (EFL) teaching. In *The TESOL Encyclopedia of English Language Teaching* (pp. 1–7). John Wiley & Sons, Inc.

Spitzer, H. F. (1939). Studies in retention. *Journal of Educational Psychology*, *30*(9), 641.

Stockwell, G. (2010). Using mobile phones for vocabulary activities: Examining the effect of platform. *Language Learning & Technology*, *14*(2), 95–110.

Stockwell, G. (2012). *Computer-assisted language learning: Diversity in research and practice*. Cambridge University Press.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Sweller, J. (2005). *Implications of cognitive load theory for multimedia learning*. Cambridge University Press.

Sweller, J., Chandler, P., Tierney, P., & Cooper, M. (1990). Cognitive load as a factor in the structuring of technical material. *Journal of Experimental Psychology: General, 119*(2), 176–192. https://doi.org/10.1037/0096-3445.119.2.176

System Usability Scale (SUS) | Usability.gov. (2018). Usability.Gov. https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

Taheri, A. A., & Davoudi, M. (2016). The effect of the keyword method on vocabulary learning and long-term retention. *International Journal of Language and Linguistics*, *3*(1), 114–125.

Taki, S., & Khazaei, S. (2011). Learning vocabulary via mobile phone: Persian EFL learners in focus. *Journal of Language Teaching and Research*, *2*(6), 1252–1258. https://doi.org/10.4304/jltr.2.6.1252-1258

Tavakoli, M., & Gerami, E. (2013). The effect of keyword and pictorial methods on EFL learners' vocabulary learning and retention. *Porta Linguarum: Revista Internacional De Didáctica De Las Lenguas Extranjeras*, *19*, 299–316.

Thornton, P., & Houser, C. (2005). Using mobile phones in English education in Japan. *Journal of Computer Assisted Learning*, *21*(3), 217–228. https://doi.org/10.1111/j.1365-2729.2005.00129.x

Toghyani Khorasgani, A., & Khanehgir, M. (2017). Teaching new vocabulary to Iranian young FL learners: Using two methods total physical response and keyword method. *Online Submission*, *5*(1), 90–100.

Treisman, A., Davies, A., & Kornblum, S. (1973). Divided attention between eye and ear. *Attention and Perjormance IV, S. KORNBLUM (Editor). Academic Press, New York.*

Tseng, M. (2010). Factors that influence online reading: An investigation into EFL students' perceptions. *Reading*, *10*(1).

Tseng, W.-T., Dörnyei, Z., & Schmitt, N. (2006). A new approach to assessing strategic learning: The case of self-regulation in vocabulary acquisition. *Applied Linguistics*, *27*(1), 78–102. https://doi.org/10.1093/applin/ami046

Turan, Z., & Akdag-Cimen, B. (2020). Flipped classroom in English language teaching: A systematic review. *Computer Assisted Language Learning*, *33*(5–6), 590–606.

Uehara, S., & Martinez Noriega, E. J. (2016). Trends in EFL technology and educational coding: A case study of an evaluation application developed on LiveCode. *The JALT CALL Journal*, *12*(1), 57–78. https://doi.org/10.29140/jaltcall.v12n1.202

Vaezi, Z. (2008). Language learning motivation among Iranian undergraduate students. *World Applied Sciences Journal*, *5*(1), 54–61.

Valoris, M. (2015). *Mixed-methods analysis of best practices for land-grant university mobile applications from a user experience design perspective, A*. Colorado State University.

van Hell, J. G., & Mahn, A. C. (1997). Keyword mnemonics versus rote rehearsal: Learning concrete and abstract foreign words by experienced and inexperienced learners. *Language Learning*, *47*(3), 507–546. https://doi.org/10.1111/0023-8333.00018

van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review*, *17*(2), 147–177. https://doi.org/10.1007/s10648-005-3951-0

Venere, S., & Watson, J. R. (2017). Collaborative learning through social media for study-abroad and at-home Spanish language learners. *NECTFL Review*, *79*.

W3C. (2021, March 14). Mobile Web. *Mobile Web*. https://www.w3.org/standards/webdesign/mobilweb

Wahl, H., & Winiwarter, W. (2011). *The intelligent integrated computer-assisted language learning (iiCALL) environment*. Proceedings of the 13th International Conference on Information Integration and Web-based Applications and Services - iiWAS '11.

Walters, J. L. (2012). *English language learners' reading self-efficacy and achievement using 1: 1 mobile learning devices*. UC San Diego.

Wang, C. X., Song, H., Xia, F., & Yan, Q. (2009). Integrating second life into an EFL program: Students' perspectives. *Journal of Educational Technology Development and Exchange*, *2*(1). https://doi.org/10.18785/jetde.0201.01

Warschauer, M. (2004). *Technology and social inclusion*. The MIT Press.

Warschauer, M., & Liaw, M.-L. (2011). Emerging technologies for autonomous language learning. *Studies in Self-Access Learning Journal*, 107–118. https://doi.org/10.37237/020302

Warschauer, M., Shetzer, H., & Meloni, C. F. (2000). *Internet for English teaching*. Tesol Alexandria.

Watkins, J., & Wilkins, M. (2011). Using YouTube in the EFL classroom. *Language Education in Asia*, *2*(1), 113–119. https://doi.org/10.5746/leia/11/v2/i1/a09/watkins_wilkins

Welling, L., & Thomson, L. (2003). *PHP and MySQL web development*. Sams Publishing.

What is JavaScript. MDN web docs. (2020).

Wittrock, M. C., Marks, C., & Doctorow, M. (1975). Reading as a generative process. *Journal of Educational Psychology*, *67*(4), 484.

Worthen, J. B., & Hunt, R. R. (2011). *Mnemonology*. Psychology Press.

Wu, W. V., Yen, L. L., & Marek, M. (2011). Using online EFL interaction to increase confidence, motivation, and ability. *Journal of Educational Technology & Society*, *14*(3), 118–129.

Wyra, M. (2019). Problem solving using the keyword method and mental imagery during vocabulary recall. In *Problem Solving for Teaching and Learning* (pp. 192–208). Routledge.

Wyra, M., & Lawson, M. J. (2018). Foreign language vocabulary learning using the keyword method: Strategy and meta-strategy knowledge. *The Language Learning Journal*, *46*(5), 605–621.

Wyra, M., Lawson, M. J., & Hungi, N. (2007). The mnemonic keyword method: The effects of bidirectional retrieval training and of ability to image on foreign language vocabulary recall. *Learning and Instruction*, *17*(3), 360–371. https://doi.org/10.1016/j.learninstruc.2007.02.008

Yaghoubinejad, H., Zarrinabadi, N., & Nejadansari, D. (2016). Culture-specificity of teacher demotivation: Iranian junior high school teachers caught in the newly-introduced CLT trap! *Teachers and Teaching*, *23*(2), 127–140. https://doi.org/10.1080/13540602.2016.1205015

Yi, H., & Majima, J. (1993). The teacher-learner relationship and classroom interaction in distance learning: A case study of the japanese language classes at an American high school. *Foreign Language Annals*, *26*(1), 21–30. https://doi.org/10.1111/j.1944-9720.1993.tb01147.x

Young, D. J. (1991). Creating a low-anxiety classroom environment: What does language anxiety research suggest? *The Modern Language Journal*, *75*(4), 426–437. https://doi.org/10.1111/j.1540-4781.1991.tb05378.x

Zarrabi, F. (2017). How explicit listening strategy instruction affects listening comprehension of different learners. *Journal of Language Teaching and Research*, *8*(4), 655.

Zhang, B., & Li, C. (2011). Classification of L2 vocabulary learning strategies: Evidence from exploratory and confirmatory factor analyses. *RELC Journal*, *42*(2), 141–154.

Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker, J. F. (2004). Can e-learning replace classroom learning? *Communications of the ACM*, *47*(5), 75–79. https://doi.org/10.1145/986213.986216

Zhou, D., Zhang, Z., Zhong, S., & Xie, P. (2008). *The design of software architecture for e-learning platforms*. Springer Berlin Heidelberg.

Zimmerman, B. J., & Schunk, D. H. (2001). *Self-regulated learning and academic achievement: Theoretical perspectives*. Routledge.

Zimmerman, C. B. (1996). *Historical trends in second language vocabulary instruction*. Cambridge University Press.

Zohrabi, M., Torabi, M. A., & Baybourdiani, P. (2012). Teacher-centered and/or student-centered learning: English language in Iran. *English Language and Literature Studies*, *2*(3), 18.

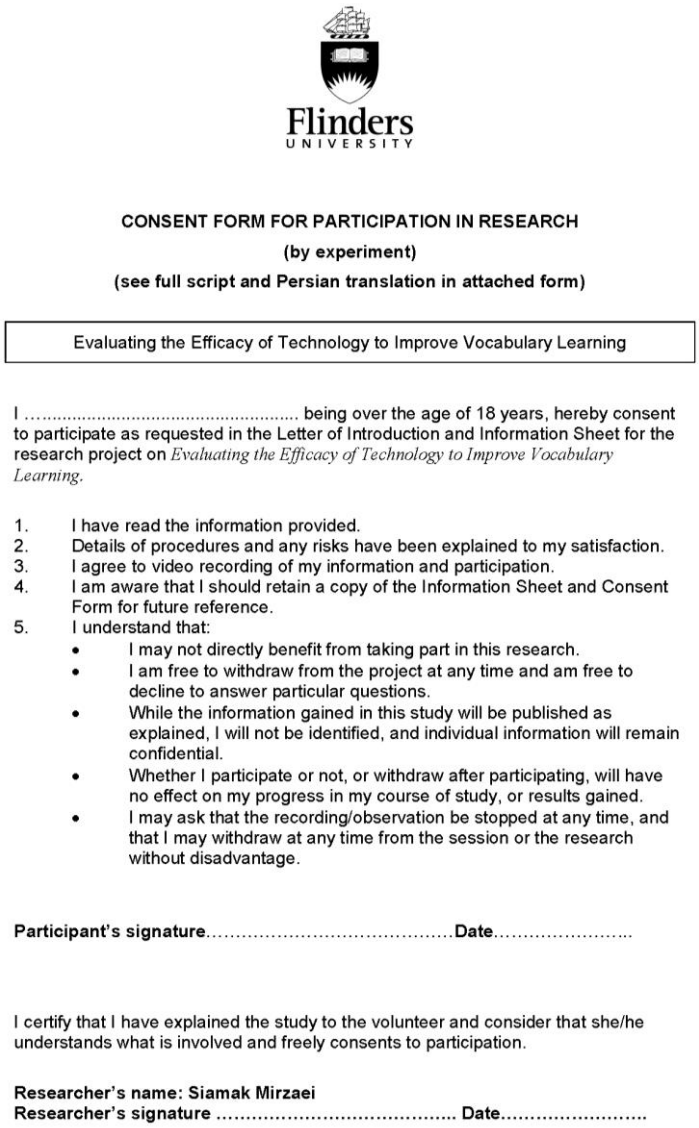
Zwicklbauer, M., Krauss, C., Merceron, A., Kania, J.-P., & Scharp, M. (2015). Smart learning: Der digitale lernbegleiter für die berufliche bildung. *DeLFI 2015--Die 13. E-Learning Fachtagung Informatik.*

APPENDICES

Please note that all forms and documents utilised in this research study were in Persian. The English samples are provided for demonstration and comprehension purposes only.

I. Consent Form

English Consent Form (for demonstration and comprehension purposes only)



Flinders
UNIVERSITY

CONSENT FORM FOR PARTICIPATION IN RESEARCH

(by experiment)

(see full script and Persian translation in attached form)

Evaluating the Efficacy of Technology to Improve Vocabulary Learning

I ..... being over the age of 18 years, hereby consent to participate as requested in the Letter of Introduction and Information Sheet for the research project on *Evaluating the Efficacy of Technology to Improve Vocabulary Learning.*

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to video recording of my information and participation.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:
   - I may not directly benefit from taking part in this research.
   - I am free to withdraw from the project at any time and am free to decline to answer particular questions.
   - While the information gained in this study will be published as explained, I will not be identified, and individual information will remain confidential.
   - Whether I participate or not, or withdraw after participating, will have no effect on my progress in my course of study, or results gained.
   - I may ask that the recording/observation be stopped at any time, and that I may withdraw at any time from the session or the research without disadvantage.

Participant's signature……**Date**……..

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name: Siamak Mirzaei
Researcher's signature …….. **Date**……..

Figure 34. Consent form – English (for demonstration and comprehension purposes only)

Persian Consent Form

موافقتنامه جهت شرکت در پژوهش (آزمایش محور)

(متن کامل و ترجمهٔ فارسی به فرم ضمیمه شده است)

ارزیابی تاثیر تکنولوژی برتقویت یادگیری کلمات

اینجانب ..... بیش از ۱۸ سال داشته و موافقت خود را به منظور شرکت در این آزمایش همان‌گونه که در مقدمه‌نامه و برگهٔ اطلاعات مربوط به پروژه تحقیقاتی « ارزیابی تاثیر تکنولوژی برتقویت یادگیری کلمات » اعلام می‌دارم.

۱. من اطلاعات ارائه‌شده را مطالعه کرده‌ام.
۲. جزئیات روش‌ها و هر گونه خطر احتمالی برای من به خوبی شرح داده شده است.
۳. من با ضبط ویدیویی اطلاعات و حضورم در این پژوهش موافقم.
٤. من آگاهم که می‌باید نسخه‌ای از برگهٔ اطلاعات و موافقتنامه را جهت ارجاعات آینده نگهداری نمایم.
٥. من آگاهم که:

- شاید به طور مستقیم از شرکت در این پژوهش سودی نبرم.
- آزادم هر زمانی که بخواهم از ادامهٔ شرکت در این پروژه خودداری کنم و آزادم که به برخی از پرسش‌ها پاسخ ندهم.
- با وجود اینکه اطلاعات به‌دست‌آمده از این مطالعه مطابق توضیحات قبلی انتشار خواهد یافت، هویت من برملا نخواهد شد و اطلاعات شخصی‌ام محرمانه باقی خواهد ماند.
- چه در این پژوهش شرکت کنم یا نه، چه در میانهٔ آن انصراف دهم، تأثیری بر روند پیشرفت واحد مطالعاتی‌ام یا نتایج حاصله از آن نخواهد داشت.
- هر زمانی ممکن است که بخواهم ضبط/مشاهدات متوقف شود، و هر زمانی می‌توانم از ادامهٔ شرکت در مصاحبه یا پژوهش خودداری کنم، بدون اینکه ضرری متوجهم شود.

امضای شرکت‌کننده ..... **تاریخ** .....

من تضمین می‌دهم که این پروژه را برای داوطلب شرح داده‌ام به نحوی که او نسبت به ابعاد آن آگاه بوده و آزادانه با شرکت در آن موافقت کرده است.

پژوهشگر: سیامک میرزایی
امضاء:
تاریخ:

Figure 35. Consent form – Persian

II. Information Sheet

English Information Sheet (for demonstration and comprehension purposes only)

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CRICOS Provider No. 00114A

INFORMATION SHEET

Title:
Evaluating the Efficacy of Technology to Improve Vocabulary Learning

Investigators:
Mr Siamak Mirzaei
College of Science and Engineering
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Description of the study:

This study aims to evaluate the efficacy and usability of using electronic devices to learn new vocabulary items. Mnemonic learning methodology will be implemented within computer device application. In mnemonic learning methodology, a vocabulary item is taught via a keyword and an image beside the vocabulary item itself and its meaning. While the primary device type used will be a tablet, pen and paper will be included as a means of comparison that represents commonly used traditional method.
The motivation for studying computer devices is that they offer a self-contained package for vocabulary learning and a low cost/barrier of entry for end users and developers. Also, portability and self-learning are other advantages of our method over the traditional one. Given these factors and their overall popularity, computer devices are more likely to play an important role in future adoption and acceptance of vocabulary learning of a new language.

This study is supported by the College of Science and Engineering.

Purpose of the study:
This study aims to find out:

1

Figure 36. Information sheet page 1 – English (for demonstration and comprehension purposes only)

- Establish whether a computer device offers a usable and effective means of learning vocabulary items.
- Investigate whether there is any advantage to being able to use computer devices for learning vocabulary items.
- Compare pen and paper traditional method with a computer device to discover what advantages/disadvantages each has, and which users prefer.
- Determine whether a computer device is beneficial to novice learners. Whether there is any advantage to being able to author in-environment.

What will I be asked to do?
The study has been broken up into five phases.
In the first phase, all participants will be invited to provide background information (demographics, participants degree of familiarity with computer devices for vocabulary learning and their preference). The experiment groups will be asked to learn the keyword method. The keyword method instruction will be delivered via a video presentation. Experimental pen and paper and app groups will have the video keyword method training. Then, participants will be asked to complete the AMIe questionnaire. This will be also used as a distraction between the learning of the method and its application in phase 2 to learning new word-pairs (Persian-English).
Phase 1 will be completed individually.

The second phase will ask participants to use the pen and paper traditional method or an app on the university/institute computer device to learn the first set of vocabulary items (22 Persian-English word-pairs). The participants will then have a distraction activity to help them stop thinking about the words that they have learned. This will be done by a simple app game (for the app groups) or chitchat (for the pen and paper groups).

This is a vocabulary testing phase. Participants' vocabulary recall will be tested on 4 occasions: Day 1 (immediately after phase 2 distraction), day 5, day 9 and day 13. Pen and paper groups will have pen and paper tests and app groups will have a test build within the app. All tests will have the same structure and sequence of words for all groups. Just the method of test delivery will be different, i.e. via app or on paper.

In this phase, participants will learn the second word set (another 22 Persian-English word-pairs) and are distracted by a game or chitchat based on the participant group after learning the vocabulary items after learning the vocabulary items. (same as phase 2)

The fifth phase will present participants with a test on the learnt vocabulary items which will be conducted within the app or using pen and paper on different occasions/days/times (same design as in phase 3). After each method has been used, a SUS (System Usability Scale) questionnaire approved by SBREC for Project 8374, AMIe questionnaire and open-ended questionnaire will be completed based on the participant groups.

The study will take place the School of Engineering for Karaj Islamic Azad University and Nirvana Language Institute students. Phase one is expected to take around 30 minutes to complete while phases two and four take 10 minutes. Phases 3 and 5 are expected to be 35 and 60 minutes respectively. Participation in this study is completely voluntary and there are no penalties by choosing not to participate. Your participation will be treated anonymously, and you will be free to withdraw at any time without consequence.

What benefit will I gain from being involved in this study?
The sharing of your experiences will help improve the planning and delivery of future studies. Furthermore, the data collected will assist with future development of mobile learning which helps foreign language learners to memorise the meaning of new vocabulary items easier and faster. Likewise, learning via this

Figure 37. Information sheet page 2 – English (for demonstration and comprehension purposes only)

method will be more indulging and a greater number of vocabulary words can be acquired. In a nutshell, our study results in lower learning curve, higher learning pace and improved learning experience.

Will I be identifiable by being involved in this study?
Participation is completely anonymous. All questionnaire responses, video recordings, and transcribed interview comments will be de-identified and not directly linked to you.

Are there any risks or discomforts if I am involved?
It is not expected that any risks or discomforts will arise from participation in the study.

Where will the study take place?
The study will take place the School of Engineering for Karaj Islamic Azad University and Nirvana Language Institute students. Phase one is expected to take around 30 minutes to complete while phases two and four take 10 minutes. Phases 3 and 5 are expected to be 35 and 60 minutes respectively. Participation in this study is completely voluntary and there are no penalties by choosing not to participate. Your participation will be treated anonymously, and you will be free to withdraw at any time without consequence.

Participation requirements:
You must be at least 18 years of age to participate. No prior experience with handheld devices or augmented reality is necessary.

How do I agree to participate?
You can agree to participate by responding to the email with your preferred training session and experiment times. You will also need to complete the attached consent forms. You will then receive a confirmation email with details of your booking, which includes your times and the location of the experiment. You will need to bring the completed consent forms with you when you come along to the training session.

Participation in this study is voluntary. You may withdraw at any time without consequence.

How will I receive feedback?
It is anticipated that the results of this study will be published in a journal or conference article. The results will also be included in the principle researcher's research project thesis.

Thank you for taking the time to read this information sheet and we hope that you will accept our invitation to be involved.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project number 8374). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Figure 38. Information sheet page 3 – English (for demonstration and comprehension purposes only)

Persian Information Sheet

برگه اطلاعات

عنوان:

ارزیابی تاثیر تکنولوژی برتقویت یادگیری کلمات

پژوهش گر:

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شرح مطالعه:

هدف از این مطالعه ارزیابی اثربخشی و قابلیت استفاده از تکنولوژی برای یادگیری واژگان جدید است. روش یادگیری حافظه‌محور در نرم افزار در دستگاه قابل حمل پیاده سازی خواهد شد. در روش یادگیری حافظه‌محور ، یک واژه توسط کلمه ای کلیدی و یک تصویر در کنار معنای آن تدریس می شود. در حالی که دستگاه مورد استفاده تبلت خواهد بود، قلم و کاغذ جهت مقایسه و به عنوان روش معمول سنتی استفاده می شود.
انگیزه برای مطالعه دستگاه های قابل حمل، خصوصیت آنها به عنوان یک بسته یادگیری واژگان با هزینه / موانع کم برای کاربران و توسعه دهندگان می‌باشد. همچنین قابلیت انتقال و خودآموزی از دیگر مزایای استفاده از روش ما نسبت به روش سنتی است. با توجه به این عوامل و محبوبیت کلی آنها، دستگاه های قابل حمل بیشتر در پذیرش و قبول یادگیری واژگان یک زبان جدید نقش مهمی ایفا می کنند.
این مطالعه توسط دانشکده علوم و مهندسی پشتیبانی می شود.

هدف مطالعه

هدف از این مطالعه بر آن است تا دریابد:

- تعیین اینکه آیا یک دستگاه همراه ابزاری قابل استفاده و موثر برای یادگیری واژگان است.
- بررسی و امکان سنجی مزیت استفاده از دستگاه های همراه برای یادگیری واژگان .
- مقایسه روش قلم و کاغذ سنتی با یک دستگاه همراه برای یافتن مزایا و معایب هر روش و ترجیح کاربران.
- تعیین اینکه آیا یک دستگاه همراه برای مبتدیان تازه کار مفید است یا خیر.

inspiring achievement

Figure 39. Information sheet page 1 – Persian

من چه کارهایی باید انجام دهم؟

این مطالعه به پنج مرحله تقسیم شده است.
در مرحله اول، از همه شرکت کنندگان خواسته می شود تا اطلاعات پس زمینه (سن، جنسیت، میزان آشنایی با دستگاه های رایانه ای برای یادگیری واژگان و اولویت های آنها) کامل کنند. گروههای آزمایشی خواسته خواهند شد تا روش کلمه کلیدی را یاد بگیرند. دستورالعمل روش ذکرشده از طریق ویدئو نمایش خواهد شد. گروههای آزمایشی این ویدئو را خواهند دید. سپس از شرکت کنندگان درخواست خواهد شد که پرسشنامه AMIe را تکمیل کنند. این نیز به عنوان یک اختلال بین یادگیری روش و کاربرد آن در مرحله ۲ برای یادگیری لغات جدید (فارسی-انگلیسی) مورد استفاده قرار می گیرد.
مرحله ۱ به صورت جداگانه تکمیل خواهد شد.
در مرحله دوم از شرکت کنندگان می خواهیم از روش قلم و کاغذ سنتی یا یک برنامه در دستگاه کامپیوتری دانشگاه / مؤسسه برای استفاده از اولین مجموعه از واژگان (۲۲ اصطلاح فارسی و انگلیسی) استفاده کنند. شرکت کنندگان پس از آن به فعالیت هایی جهت پرت کردن حواس خود برای کمک توقف فکر در مورد کلماتی که آنها آموخته اند، می پردازند. این کار با یک بازی برنامه ساده (برای گروه برنامه) و یا گپ زدن (برای گروه قلم و کاغذ) انجام می شود.
این یک مرحله آزمایش واژگان است. یادآوری واژگان شرکت کنندگان در ٤ مرحله آزمایشی خواهد بود: روز اول (بلافاصله پس از انفجار مرحله ۲)، روز ٥، روز ۹ و روز ۱۳. گروههای قلم و کاغذ، آزمونهای قلم و کاغذی و گروه های برنامه، در داخل برنامه آزمون خواهند داشت. تمام آزمونها یک ساختاردارند و کلمات برای همه گروه ها یکسان است. فقط روش تحویل آزمون متفاوت است، از طریق برنامه یا بر روی کاغذ.
در این مرحله، شرکت کنندگان مجموعه دوم کلمه (۲۲ کلمه انگلیسی-فارسی) را یاد می گیرند و پس از یادگیری واژگان، به وسیله ی یک بازی یا گپ زدن بر اساس گروه شرکت کننده، این کلمات را یاد می گیرند. (مشابه مرحله ۲)
در مرحله پنجم شرکت کنندگان یک آزمون در مورد واژگان آموخته شده که در برنامه و یا با استفاده از قلم و کاغذ در زمان های ذکر شده/ روزهای مختلف است، می دهند (همانند مرحله ۳). پس از استفاده از هر روش، پرسشنامه SUS (مقیاس پذیری سیستم) که توسط SBREC برای پروژه ۸۳۷٤ تایید شده است، پرسشنامه AMIe و پرسشنامه open-ended بر اساس گروه های شرکت کننده انجام می شود.
این مطالعه در در دانشکده فنی دانشگاه آزاد اسلامی کرج و یا موسسه نیروانا برگزار خواهد شد. انتظار می رود مرحله اول حدود ۳۰ دقیقه طول بکشد، در حالی که مرحله های دو و چهار دقیقه ۱۰ دقیقه طول می کشد. شرکت در این مطالعه به طور کامل داوطلبانه است و با عدم انتخاب شرکت در آزمایش مجازاتی متوجه شما نمی شود. مشارکت شما به صورت ناشناس انجام می شود و شما بدون هیچ پی آمدی می توانید در هر زمانی از آن خارج شوید.

من از شرکت در این مطالعه چه سودی می‌برم؟

به اشتراک گذاری تجربیات شما به بهبود برنامه ریزی و تحویل مطالعات آینده کمک خواهد کرد. علاوه بر این، داده ها جمع آوری شده به توسعه آینده آموزش به زبان آموزان زبان خارجی توسط دستگاه های همراه کمک می کند کند تا معنی واژگان جدید را به راحتی و سریع تر حفظ کنند. به همین ترتیب، یادگیری از طریق این روش جذابیت بیشتری خواهد داشت و تعداد بیشتری از کلمات را می توان به آموخت. به طور خلاصه، مطالعه ما باعث سختی یادگیری کم تر، سرعت یادگیری بالاتر و بهبود تجربه یادگیری می شود.

آیا شرکت در این مطالعه به صورت ناشناس است؟

مشارکت کاملا ناشناس است. تمام پاسخ های پرسشنامه، ضبط ویدیو و نظرات شما در حین مصاحبه به صورت نا شناس مورد استفاده قرار می گیرد و به طور مستقیم به شما مرتبط نیست.

در صورت مشارکت، آیا خطرات یا ناراحتی بران من وجود دارد؟

انتظار نمی رود که هر مشکلی یا ناراحتی از مشارکت در مطالعه ناشی شود.

محل انجام مطالعه کجاست؟

این مطالعه در در دانشکده فنی دانشگاه آزاد اسلامی کرج و یا موسسه نیروانا برگزار خواهد شد. انتظار می رود مرحله اول حدود ۳۰ دقیقه طول بکشد، در حالی که مرحله های دو و چهار دقیقه ۱۰ دقیقه طول می کشد. شرکت در این مطالعه به طور کامل داوطلبانه است و با عدم انتخاب شرکت در آزمایش مجازاتی متوجه شما نمی شود. مشارکت شما به صورت ناشناس انجام می شود و شما بدون هیچ پی آمدی می توانید در هر زمانی از آن خارج شوید.

الزامات مشارکت:

برای مشارکت باید حداقل ۱۸ سال سن داشته باشید. تجربه قبلی با دستگاه های همراه و یا واقعیت افزوده، لازم نیست.

چگونه می توانم مشارکت کنم؟

شما می توانید با پاسخ به ایمیل با انتخاب جلسه تمرینی مورد نظرو زمان انجام آزمایش موافقت کنید. شما همچنین باید فرم های موافقت‌نامه پیوست شده را تکمیل کنید. پس از آن، یک ایمیل تأییدیه با جزئیات رزرو شما دریافت خواهید کرد که شامل زمان و مکان آزمایش می شود. وقتی به جلسه تمرین می روید، باید فرم های رضایت کامل را با خود داشته باشید.
مشارکت دراین مطالعه داوطلبانه است. شما ممکن است در هر زمان بدون هیچ پی آمدی انصراف دهید.

Figure 40. Information sheet page 2 – Persian

چگونه می توانم بازخورد دریافت کنم؟

پیش بینی شده است که نتایج این مطالعه در یک مجله یا مقاله کنفرانس منتشر خواهد شد. نتایج در پایان نامه پژوهشی اصلی محقق نیز انتشار خواهد یافت.

از شما متشکریم که زمان برای خواندن این برگه اطلاعات گذاشتید و امیدواریم دعوت ما را برای شرکت در این آزمایش قبول کنید.

این پروژه تحقیقاتی توسط کمیته تحقیقاتی اخلاق تحقیقاتی اجتماعی و رفتاری دانشگاه فلیندرز (شماره پروژه ۸۳۷٤) تایید شده است. برای کسب اطلاعات بیشتر در مورد تصویب اخلاقی پروژه، می توانید با شماره تلفن ۸۲۰۱ ۳۱۱٦، با شماره فکس ۸۲۰۱ ۲۰۳۵ یا ایمیل *human.researchethics@flinders.edu.au* با مدیر اجرایی کمیته ارتباط برقرار کنید.

Figure 41. Information sheet page 3 – Persian

III. Letter of Introduction

English Letter of Introduction (for demonstration and comprehension purposes only)

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LETTER OF INTRODUCTION

Dear Sir/Madam

This letter is to introduce Siamak Mirzaei who is studying a Doctor of Philosophy in the College of Science and Engineering at Flinders University. He will provide his student card, which carries a photograph, as proof of identity. He is undertaking research leading to the production of a thesis on the subject of mobile assisted language learning (MALL) and mobile learning (m-learning).
He would like to invite you to assist with this project by participating in an experiment designed to evaluate the usability of computer devices in learning vocabulary of a new language. The device being targeted for this experiment include an electronic device and pen and paper traditional method. The experiment will be split into five phases. In the first phase, all participants will be invited to provide background information (demographics, participants degree of familiarity with computer devices for vocabulary learning and their preference). The experiment groups will be asked to learn the keyword method. The keyword method instruction will be delivered via a video presentation. Experimental pen and paper and app groups will have the video keyword method training. Then, participants will be asked to complete the AMIe questionnaire. This will be also used as a distraction between the learning of the method and its application in phase 2 to learning new word-pairs (Persian-English).
Phase 1 will be completed individually.
The second phase will ask participants to use the pen and paper traditional method or an app on the university/institute computer device to learn the first set of vocabulary items (22 Persian-English word-pairs). The participants will then have a distraction activity to help them stop thinking about the words that they have learned. This will be done by a simple app game (for the app groups) or chitchat (for the pen and paper groups).
This is a vocabulary testing phase. Participants' vocabulary recall will be tested on 4 occasions: Day 1 (immediately after phase 2 distraction), day 5, day 9 and day 13. Pen and paper groups will have pen and paper tests and app groups will have a test build within the app. All tests will have the same structure and sequence of words for all groups. Just the method of test delivery will be different, i.e., via app or on paper.
In this phase, participants will learn the second word set (another 22 Persian-English word-pairs) and are distracted by a game or chitchat based on the participant group after learning the vocabulary items after learning the vocabulary items. (same as phase 2)
The fifth phase will present participants with a test on the learnt vocabulary items which will be conducted within the app or using pen and paper on different occasions/days/times (same design as in phase 3). After each method has been used, a SUS (System Usability Scale) questionnaire approved by SBREC for Project 8374, AMIe questionnaire and open-ended questionnaire will be completed based on the participant groups.
The study will take place the School of Engineering for Karaj Islamic Azad University and Nirvana Language Institute students. Phase one is expected to take around 30 minutes to complete while phases two and four take 10 minutes. Phases 3 and 5 are expected to be 35 and 60 minutes respectively. Participation in this study is completely voluntary and there are no penalties by choosing not to participate. Your participation will be treated anonymously, and you will be free to withdraw at any time without consequence.
Be assured that any information provided will be treated in the strictest confidence and none of the participants will be individually identifiable in the resulting thesis, report, or other publications. Participation is voluntary, and you are, of course, entirely free to discontinue your participation at any time or to decline to answer particular questions.
Any enquiries you may have concerning this project should be directed to me at the address given above or by telephone (82013662) or email (trent.lewis@flinders.edu.au).
Thank you for your attention and assistance.
Yours sincerely

Dr Trent Lewis
Lecturer

Figure 42. Letter of introduction – English (for demonstration and comprehension purposes only)

Persian Letter of Introduction

مقدمه‌نامه

جناب آقای/سرکار خانم

این نامه جهت معرفی آقای سیامک میرزایی به شما تنظیم شده است. وی به عنوان دانشجوی دکترا در دانشکدهٔ علوم مهندسی دانشگاه فلیندرز مشغول به تحصیل است. او برای احراز هویت خود، کارت دانشجویی عکس‌دار خود را ارائه خواهد داد. پژوهش او در زمینهٔ یادگیری زبان از طریق دستگاه‌های قابل‌حمل بوده و در راستای رساله او در همین زمینه است.

آقای میرزایی مایل است تا از شما جهت همکاری در این پروژه از طریق شرکت در یک آزمایش طراحی‌شده دعوت به عمل آورد؛ آزمایشی جهت ارزیابی قابلیت استفادهٔ دستگاه‌های الکترونیکی در یادگیری واژگان زبانی جدید. دستگاه‌های هدف در این آزمایش شامل یک رایانه و شیوهٔ سنتی نگارش با کاغذ و قلم است. آزمایش به پنج مرحله تقسیم شده است. در مرحله اول، از همه شرکت کنندگان خواسته می شود تا اطلاعات پس زمینه (سن، جنسیت، میزان آشنایی با دستگاه های رایانه ای برای یادگیری واژگان و اولویت های آنها) کامل کنند. گروههای آزمایشی خواسته خواهند شد تا روش کلمه کلیدی را یاد بگیرند. دستورالعمل روش ذکرشده از طریق ویدئو نمایش خواهد شد. گروههای آزمایشی این ویدئو را خواهند دید. سپس از شرکت کنندگان درخواست خواهد شد که پرسشنامه AMIe را تکمیل کنند. این نیز به عنوان یک اختلال بین یادگیری روش و کاربرد آن در مرحله ۲ برای یادگیری لغات جدید (فارسی-انگلیسی) مورد استفاده قرار می گیرد.

مرحله ۱ به صورت جداگانه تکمیل خواهد شد.

در مرحله دوم از شرکت کنندگان می خواهیم از روش قلم و کاغذ سنتی یا یک برنامه در دستگاه کامپیوتری دانشگاه / مؤسسه برای استفاده از اولین مجموعه از واژگان (۲۲ اصطلاح فارسی و انگلیسی) استفاده کنند. شرکت کنندگان پس از آن به فعالیت هایی جهت پرت کردن حواس خود برای کمک توقف فکر در مورد کلماتی که آنها آموخته اند، می پردازند. این کار با یک بازی برنامه ساده (برای گروه برنامه) و یا گپ زدن (برای گروه قلم و کاغذ) انجام می شود.

این یک مرحله آزمایش واژگان است. یادآوری واژگان شرکت کنندگان در ٤ مرحله آزمایشی خواهد بود: روز اول (بلافاصله پس از انفجار مرحله ۲)، روز ٥، روز ۹ و روز ۱۳. گروههای قلم و کاغذ، آزمونهای قلم و کاغذی و گروه های برنامه، در داخل برنامه آزمون خواهند داشت. تمام آزمونها یک ساختاردارند و کلمات برای همه گروه ها یکسان است. فقط روش تحویل آزمون متفاوت است، از طریق برنامه یا بر روی کاغذ.

در این مرحله، شرکت کنندگان مجموعه دوم کلمه (۲۲ کلمه انگلیسی-فارسی) را یاد می گیرند و پس از یادگیری واژگان، به وسیله ی یک بازی یا گپ زدن بر اساس گروه شرکت کننده، این کلمات را یاد می گیرند. (مشابه مرحله ۲)

در مرحله پنجم شرکت کنندگان یک آزمون در مورد واژگان آموخته شده که در برنامه و یا با استفاده از قلم و کاغذ در زمان های ذکر شده/ روزهای مختلف است، می دهند (همانند مرحله ۳). پس از استفاده از هر روش، پرسشنامه SUS (مقیاس پذیری سیستم) که توسط SBREC برای پروژه ۸۳۷٤ تایید شده است، پرسشنامه AMIe و پرسشنامه open-ended بر اساس گروه های شرکت کننده انجام می شود.

این مطالعه در در دانشکده فنی دانشگاه آزاد اسلامی کرج و یا موسسه نیروانا برگزار خواهد شد. انتظار می رود مرحله اول حدود ۳۰ دقیقه طول بکشد، در حالی که مرحله های دو و چهار دقیقه ۱۰ دقیقه طول می کشد. شرکت در این مطالعه به طور کامل داوطلبانه است و با عدم انتخاب شرکت در آزمایش مجازاتی متوجه شما نمی شود. مشارکت شما به صورت ناشناس انجام می شود و شما بدون هیچ پی آمدی می توانید در هر زمانی از آن خارج شوید.

در صورتی که علاقمند به کسب هر گونه اطلاعاتی در مورد این پروژه هستید، لطفاً از طریق شماره تلفن 61882013662+ یا آدرس ایمیل trent.lewis@flinders.edu.au با من تماس بگیرید. از توجه و همکاری شما سپاسگزارم.

با احترام،

دکتر ترنت لوییس

Figure 43. Letter of introduction – Persian

IV. Recruitment Email

English Recruitment Email (for demonstration and comprehension purposes only)

Recruitment email (#1)

Hello

This email is to introduce you to Siamak Mirzaei who is a current Doctor of Philosophy (PhD) student in the College of Science and Engineering (CSE) at Flinders University. His research interests include Computer Assisted Language Learning (CALL) / Mobile Assisted Language Learning (MALL).

He is currently investigating potential usability issues involved with using smartphones for learning words in a new language. He is particularly interested in whether there is any advantage in terms of learning curve, learning pace and learning experience while exploiting a mobile device for learning a new word.

He is seeking volunteers to participate in a usability study to assist with this research. The study will involve participants using a smartphone and a pen and paper—to learn a word. The word will be taught via its meaning, a keyword and an image. The study has been split into three phases. The first phase takes place at a separate time to the second and third phase so as to make best use of participants' time.

In the first phase, all participants will be invited to provide background information (demographics, participants degree of familiarity with computer devices for vocabulary learning and their preference). The experiment groups will be asked to learn the KWM. The KWM instruction will be delivered via a video presentation. Experimental pen and paper and app groups will have the video KWM training. Then, participants will be asked to complete the AMIe questionnaire. This will be also used as a distraction between the learning of the method and its application in phase 2 to learning new word-pairs (Persian-English).

Phase 1 will be completed individually.

The second phase will ask participants to use the pen and paper traditional method or an app on the university/institute computer device to learn the first set of words (22 Persian-English word-pairs). The participants will then have a distraction activity to help them stop thinking about the words that they have learned. This will be done by a simple app game (for the app groups) or chitchat (for the pen and paper groups).

This is a vocabulary testing phase. Participants' vocabulary recall will be tested on 4 occasions: Day 1 (immediately after phase 2 distraction), day 5, day 9 and day 13. Pen and paper groups will have pen and paper tests and app groups will have a test build within the app. All tests will have the same structure and sequence of words for all groups. Just the method of test delivery will be different, i.e. via app or on paper.

In this phase, participants will learn the second word-set (another 22 Persian-English word-pairs) and are distracted by a game or chitchat based on the participant group after learning the words after learning the words (same as phase 2)

The fifth phase will present participants with a test on the learnt words which will be conducted within the app or using pen and paper on different occasions/days/times (same design as in phase 3). After each method has been used, a SUS (System Usability Scale) questionnaire approved by SBREC for Project 8374, AMIe questionnaire and open-ended questionnaire will be completed based on the participant groups.

The study will take place the School of Engineering for Karaj Islamic Azad University and Nirvana Language Institute students. Phase one is expected to take around 30 minutes to complete while phases two and four take 10 minutes. Phases 3 and 5 are expected to be 35 and 60 minutes respectively. Participation in this study is completely voluntary and there are no penalties by choosing not to participate. Your participation will be treated anonymously, and you will be free to withdraw at any time without consequence.

If you are interested in participating or would like further information, please reply directly to Siamak (mirz0015@flinders.edu.au). Siamak will then send you an information pack (attached via email) containing an information sheet, letter of introduction, and experiment consent form. He will also include a list of available timeslots for training sessions (phase one) and experiment participation (phases two and three).

If for whatever reason you do not wish to participate, simply ignore this email.

This project has been granted ethical approval by the Social and Behavioural Research Ethics Committee (SBREC) and has been assigned project number 8374.

Thank you for your time.

Trent Lewis

Information

pack email (#2)

Hello

Thank you for expressing interest in the study *Evaluating the Efficacy of Technology to Improve Vocabulary Learning* and requesting further information. Please find attached an information pack containing an information sheet, letter of introduction, and experiment consent form. I have also included a list of available timeslots for the training session (phase one) and experiment (phases two and three).

If, after reading the documents in the information pack, you would like to participate in the study, please reply to this email indicating your preferred times on both tables below. To ensure your participation is valid, you must be able to commit to both the training and experiment. I will confirm your participation by replying with your training and experiment booking as well as the rooms where the training and experiment will take place. The location will be the Flinders University Tonsley building or KIAU or Nirvana Institute in Iran.

You will need to complete both consent forms and bring them with you when you come along to the training session.

If for whatever reason you do not wish to participate, do not reply. This email in no way commits you to participate. If you have any questions regarding the study or any of the material in the information pack, please don't hesitate to contact me.

Thanks

<u>Training session (Phase 1)</u>. Expected time commitment: 30 minutes.

Indicate your preferred session by placing an 'X' in the appropriate box (select one session only):

	10:00	**11:00**	**14:00**
Mon 06/05/16			
Thu 09/05/16			

** example dates and times **

<u>Learning Word-set 1 and Test Occasion 1 (Phase 2 & 3)</u>. Expected time commitment: 15 minutes.

Indicate your available times in order of preference (i.e., 1, 2, 3…):

	Mon 20/05/16	**Wed 22/05/16**	**Thu 23/05/16**
10:00			
11:30	unavailable	unavailable	
13:00			
14:30			unavailable
16:00			unavailable

** example dates and times **

<u>Test Occasion 2 - 4 of Word-set 1 (Phase 3)</u>. Expected time commitment: 30 minutes.

Indicate your available times in order of preference (i.e., 1, 2, 3…):

	Mon 20/05/16	**Wed 22/05/16**	**Thu 23/05/16**
10:00			
11:30	unavailable	unavailable	
13:00			
14:30			unavailable
16:00			unavailable

** example dates and times **

<u>Learning Word-set 2 and Test Occasion 1 (Phase 4)</u>. Expected time commitment: 10 minutes.

Indicate your available times in order of preference (i.e., 1, 2, 3…):

	Mon 20/05/16	**Wed 22/05/16**	**Thu 23/05/16**
10:00			
11:30	unavailable	unavailable	
13:00			
14:30			unavailable
16:00			unavailable

** example dates and times *

<u>Test Occasion 2 - 4 of Word-set 2 and questionnaires (Phase 5)</u>. Expected time commitment: 1 hour.

Indicate your available times in order of preference (i.e., 1, 2, 3…):

	Mon 20/05/16	**Wed 22/05/16**	**Thu 23/05/16**
10:00			
11:30	unavailable	unavailable	
13:00			
14:30			unavailable
16:00			unavailable

** example dates and times **

Confirmation email (#3)

Hello

Below is your confirmed booking for the study: *Evaluating the Efficacy of Technology to Improve Vocabulary Learning*.

Please remember to complete your consent forms (experiment) and bring them along with you to the training session. If you have any questions or need to change/cancel your booking, please let me know as soon as possible.

Thanks

Learning Word-set 1 and Test Occasion 1 (Phase 2 & 3). Expected time commitment: 15 minutes.

Date / Time	Wednesday 22/05/16 at 14:30
Location	Tonsley Room 3.54

** example dates and times **

Test Occasion 2 - 4 of Word-set 1 (Phase 3). Expected time commitment: 30 minutes.

Date / Time	Wednesday 22/05/16 at 14:30
Location	Tonsley Room 3.54

** example dates and times **

Learning Word-set 2 and Test Occasion 1 (Phase 4). Expected time commitment: 10 minutes.

Date / Time	Wednesday 22/05/16 at 14:30
Location	Tonsley Room 3.54

** example dates and times **

Test Occasion 2 - 4 of Word-set 2 and questionnaires (Phase 5). Expected time commitment: 1 hour.

Date / Time	Wednesday 22/05/16 at 14:30
Location	Tonsley Room 3.54

** example dates and times **

Persian Recruitment Email

ایمیل استخدام (1#)

با سلام،

این نامه جهت معرفی آقای سیامک میرزایی به شما تنظیم شده است. وی به عنوان دانشجوی دکترا در دانشکدهٔ علوم مهندسی دانشگاه فلیندرز مشغول به تحصیل است. او برای احراز هویت خود، کارت دانشجویی عکس‌دار خود را ارائه خواهد داد. پژوهش او در زمینهٔ یادگیری زبان از طریق تکنولوژی بوده و در راستای رسالهٔ او در همین زمینه است.

او در حال حاضر در مورد مسائل مربوط به قابلیت بالقوه استفاده در استفاده از گوشی های هوشمند برای یادگیری واژگان در یک زبان جدید تحقیق می کند. او همچنین علاقه مند است که آیا از نظر سختی یادگیری، سرعت یادگیری و تجربه یادگیری در هنگام بهره گیری از یک دستگاه همراه جهت آموزش واژگان جدید مزیتی در این روش وجود دارد یا نه.

او به دنبال داوطلبان برای شرکت در یک مطالعه مفید برای کمک به این تحقیق است. این مطالعه شرکت کنندگان را با استفاده از یک گوشی هوشمند و قلم و کاغذ برای یادگیری واژگان آماده می کند. واژگان توسط معنای آن، یک کلمه کلیدی و یک تصویر آموزش داده خواهد شد. این مطالعه به سه مرحله تقسیم شده است. مرحله اول در یک زمان متفاوت از مرحله دوم و سوم می باشد تا بهترین استفاده را از زمان شرکت کنندگان شود.

در مرحله اول، از همه شرکت کنندگان خواسته می شود تا اطلاعات پس زمینه (سن، جنسیت، میزان آشنایی با دستگاه های رایانه ای برای یادگیری واژگان و اولویت های آنها) کامل کنند. گروههای آزمایشی خواسته خواهند شد تا روش کلمه کلیدی را یاد بگیرند. دستورالعمل روش ذکرشده از طریق ویدئو نمایش خواهد شد. گروههای آزمایشی این ویدئو را خواهند دید. سپس از شرکت کنندگان درخواست خواهد شد که پرسشنامه AMIe را تکمیل کنند. این نیز به عنوان یک اختلال بین یادگیری روش و کاربرد آن در مرحله 2 برای یادگیری لغات جدید (فارسی-انگلیسی) مورد استفاده قرار می گیرد.

مرحله 1 به صورت جداگانه تکمیل خواهد شد.

در مرحله دوم از شرکت کنندگان می خواهیم از روش قلم و کاغذ سنتی یا یک برنامه در دستگاه کامپیوتری دانشگاه / مؤسسه برای استفاده از اولین مجموعه از واژگان (22 اصطلاح فارسی و انگلیسی) استفاده کنند. شرکت کنندگان پس از آن به فعالیت هایی جهت پرت کردن حواس خود برای کمک توقف فکر در مورد کلماتی که آنها آموخته اند، می پردازند. این کار با یک بازی برنامه ساده (برای گروه برنامه) و یا گپ زدن (برای گروه قلم و کاغذ) انجام می شود.

این یک مرحله آزمایش واژگان است. یادآوری واژگان شرکت کنندگان در 4 مرحله آزمایشی خواهد بود: روز اول (بلافاصله پس از انفجار مرحله 2)، روز 5، روز 9 و روز 13. گروههای قلم و کاغذ، آزمونهای قلم و کاغذی و گروه های برنامه، در داخل برنامه آزمون خواهند داشت. تمام آزمونها یک ساختاردارند و کلمات برای همه گروه ها یکسان است. فقط روش تحویل آزمون متفاوت است، از طریق برنامه یا بر روی کاغذ.

در این مرحله، شرکت کنندگان مجموعه دوم کلمه (22 کلمه انگلیسی-فارسی) را یاد می گیرند و پس از یادگیری واژگان، به وسیله ی یک بازی یا گپ زدن بر اساس گروه شرکت کننده، این کلمات را یاد می گیرند. (مشابه مرحله 2)

در مرحله پنجم شرکت کنندگان یک آزمون در مورد واژگان آموخته شده که در برنامه و یا با استفاده از قلم و کاغذ در زمان های ذکر شده/ روزهای مختلف است، می دهند (همانند مرحله 3). پس از استفاده از هر روش، پرسشنامه SUS (مقیاس پذیری سیستم) که توسط SBREC برای پروژه 8374 تایید شده است، پرسشنامه AMIe و پرسشنامه open-ended بر اساس گروه های شرکت کننده انجام می شود.

این مطالعه در در دانشکده فنی دانشگاه آزاد اسلامی کرج و یا موسسه نیروانا برگزار خواهد شد. انتظار می رود مرحله اول حدود 30 دقیقه طول بکشد، در حالی که مرحله های دو و چهار دقیقه 10 دقیقه طول می کشد. شرکت در این مطالعه به طور کامل داوطلبانه است و با عدم انتخاب شرکت در آزمایش مجازاتی متوجه شما نمی شود. مشارکت شما به صورت ناشناس انجام می شود و شما بدون هیچ پی آمدی می توانید در هر زمانی از آن خارج شوید.

اگر شما علاقه مند به شرکت یا مایل به اطلاعات بیشتر هستید، لطفا مستقیما به سیامک (mirz0015@flinders.edu.au) پاسخ دهید. سیامک سپس یک بسته اطلاعاتی (از طریق ایمیل) که حاوی یک برگه اطلاعات، مقدمه، فرم رضایت آزمایشی و فرم رضایت مصاحبه است، به شما ارسال می کند. او همچنین فهرستی از زمان های موجود برای جلسات آموزشی (مرحله اول) و مشارکت در آزمایش (مراحل دو و سه) را در اختیارتان قرار خواهد داد.

اگر به هر دلیلی نمی خواهید شرکت کنید، این ایمیل را نادیده بگیرید.

این پروژه تأیید اخلاقی توسط کمیته اخلاق تحقیقات اجتماعی و رفتاری (SBREC) با شماره پروژه 8374 را داراست.

ممنون بخاطر وقتی که گذاشتید.

ترنت لوییس

ایمیل بسته اطلاعاتی (#2)

با سلام،

با تشکر از شما برای درخواست اطلاعات بیشتر و ابرازعلاقه به مطالعه ارزیابی تاثیر تکنولوژی برتقویت یادگیری کلمات. بسته اطلاعاتی حاوی برگه اطلاعات، مقدمه‌نامه، فرم موافقت‌نامه آزمایش محور و فرم موافقت‌نامه مصاحبه محور پیوست گردیده اند. من همچنین لیستی از زمان های موجود برای جلسه تمرینی (مرحله اول) و آزمایش (مراحل دو و سه) را در اختیار شما قرار داده ام.

اگر پس از خواندن اسناد موجود در بسته اطلاعاتی مایلید در این مطالعه شرکت کنید، لطفا به این ایمیل پاسخ دهید و زمان مورد نظر خود را در هر دو جدول زیراعلام کنید. برای اطمینان ازاعتبار مشارکت شما ، شما باید قادر به انجام هر دو تمرین و آزمایش باشید. من در ایمیل بعدی، شرکت در جلسات آموزشی و آزمایشی و همچنین مکان هایی که آموزش و آزمایش انجام می شود را تأیید می کنم. محل انجام آزمایش، طبقه سوم و چهارم تونسلی دانشگاه فلیندرز برای دانشجویان دانشگاه فلیندرز و در دانشکده فنی دانشگاه آزاد اسلامی کرج و یا موسسه نیروانا در ایران خواهد بود.

شما باید هر دو فرم موافقت‌نامه را تکمیل کنید و آنها را با خود در هنگام جلسه تمرین بیاورید.

اگر به هر دلیلی بخواهید شرکت نکنید، پاسخ ندهید. این ایمیل به هیچ وجه شما را وادار به مشارکت نمی کند. اگر در مورد مطالعه یا هر گونه موارد موجود در بسته اطلاعاتی سؤالی دارید، لطفا با من تماس بگیرید.

با تشکر

جلسه آموزش مرحله اول. زمان انجام:30 دقیقه.

جلسه مورد نظر خود را با قرار دادن 'X' در محل مناسب نشان دهید (یک جلسه را به صورت مستقیم انتخاب کنید):

	11:00	10:00	09:00
دوشنبه 96/05/06			
چهارشنبه 96/05/09			

مثال تاریخ و زمان

جلسه مرحله دوم و سه. زمان انجام:15 دقیقه.

جلسه مورد نظر خود را با قرار دادن 'X' در محل مناسب نشان دهید (یک جلسه را به صورت مستقیم انتخاب کنید):

09:00	10:00	11:00	
			دوشنبه 96/05/06
			چهارشنبه 96/05/09

مثال تاریخ و زمان

جلسه مرحله سه. زمان انجام:30 دقیقه.

جلسه مورد نظر خود را با قرار دادن 'X' در محل مناسب نشان دهید (یک جلسه را به صورت مستقیم انتخاب کنید):

09:00	10:00	11:00	
			دوشنبه 96/05/06
			چهارشنبه 96/05/09

مثال تاریخ و زمان

جلسه مرحله چهارم. زمان انجام:10 دقیقه.

جلسه مورد نظر خود را با قرار دادن 'X' در محل مناسب نشان دهید (یک جلسه را به صورت مستقیم انتخاب کنید):

09:00	10:00	11:00	
			دوشنبه 96/05/06
			چهارشنبه 96/05/09

مثال تاریخ و زمان

جلسه مرحله پنجم. زمان انجام: 1 ساعت.

زمان های دردسترس بودن خود را به ترتیب اولویت (به عنوان مثال 1، 2، 3 ...) نشان دهید:

	دوشنبه 16/05/06	چهارشنبه 96/05/09	چهارشنبه 96/06/09
9:00			
09:30	در دسترس	در دسترس	
10:00			
10:30			در دسترس
11:00			در دسترس

مثال تاریخ و زمان

ایمیل تاییدیه (#3)

با سلام،

زمان تایید شده شما برای مطالعه: ارزیابی تاثیر تکنولوژی برتقویت یادگیری کلمات در زیر آمده است.

لطفا به یاد داشته باشید که فرم های موافقت‌نامه (آزمایش و مصاحبه محور) را تکمیل کنید و آنها را به جلسه تمرینی بیاورید. اگر سوالی دارید یا نیاز به تغییر/ لغو زمان تایید شده دارید، لطفا به من در اسرع وقت اطلاع دهید.

با تشکر

جلسه آموزش مرحله اول. زمان انجام:30 دقیقه.

تاریخ/ زمان	دوشنبه 16/05/06 ساعت 10:00
مکان	XXX

** مثال تاریخ و زمان **

جلسه مرحله دوم و سه. زمان انجام:15 دقیقه.

تاریخ/ زمان	دوشنبه 16/05/06 ساعت 10:00
مکان	XXX

** مثال تاریخ و زمان **

جلسه مرحله سه. زمان انجام:30 دقیقه.

تاریخ/ زمان	دوشنبه 16/05/06 ساعت 10:00
مکان	XXX

** مثال تاریخ و زمان **

جلسه مرحله چهارم. زمان انجام:10 دقیقه.

دوشنبه 16/05/06 ساعت 10:00	تاریخ/ زمان
XXX	مکان

** مثال تاریخ و زمان **

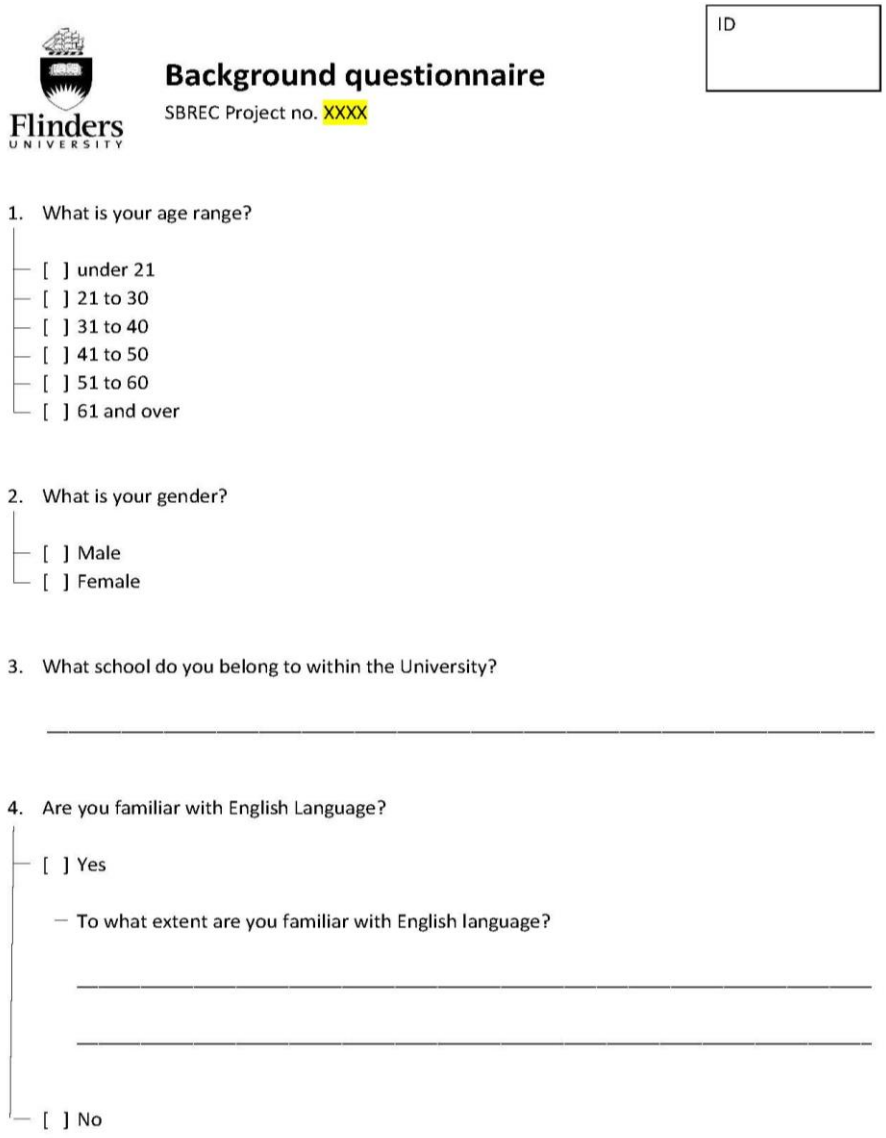
جلسه مرحله پنجم. زمان انجام: 1 ساعت.

چهارشنبه 96/06/09 ساعت 14:30	تاریخ/ زمان
دانشکده فنی مهندسی دانشگاه آزاد کرج اتاق 110	تاریخ/ زمان

** مثال تاریخ و زمان **

V. Background Questionnaire

English Background Questionnaire (for demonstration and comprehension purposes only)



Flinders UNIVERSITY

Background questionnaire

SBREC Project no. XXXX

ID

1. What is your age range?

- [ ] under 21
- [ ] 21 to 30
- [ ] 31 to 40
- [ ] 41 to 50
- [ ] 51 to 60
- [ ] 61 and over

2. What is your gender?

- [ ] Male
- [ ] Female

3. What school do you belong to within the University?

_____

4. Are you familiar with English Language?

- [ ] Yes
  - To what extent are you familiar with English language?

    _____

    _____
- [ ] No

1

Figure 44. Background questionnaire page 1 – English (for demonstration and comprehension purposes only)

Flinders UNIVERSITY

Background questionnaire

SBREC Project no. XXXX

ID

5. Do you currently own a smartphone device?

- [ ] Yes
  - What device(s) do you own?

    _____

    _____
  - Do you use your smartphone for learning vocabulary?
    - [ ] Yes. Which language do you learn?

      _____

      _____
    - [ ] No
  - Do you use pen and paper to learn vocabulary?
    - [ ] Yes. Which language do you learn?

      _____

      _____
    - [ ] No
- [ ] No

Figure 45. Background questionnaire page 2 – English (for demonstration and comprehension purposes only)

Flinders UNIVERSITY

Background questionnaire

SBREC Project no. XXXX

ID

6. Have you ever used an application to learn vocabulary on your smartphone (on any device)?

- [ ] Yes
  - Approximately how long ago?
    Please list as weeks, months, or years (as appropriate).

    _____
  - Overall, did you enjoy the experience?
    - [ ] Yes
    - [ ] No. Why not?

      _____

      _____
- [ ] No
- [ ] Don't know

That completes the background questionnaire. Please return it to your test moderator.

Figure 46. Background questionnaire page 3 – English (for demonstration and comprehension purposes only)

Persian Background Questionnaire

شناسه
G3 -

پرسش نامه پیش زمینه
شماره پروژه ۸۳۷٤

۱. محدوده سنی شما چیست؟

-[ ] زیر ۲۱ سال -[ ] ۲۱-۳۰ سال -[ ] ۳۱ تا ٤۰ سال

-[ ] ٤۱ تا ۵۰ سال -[ ] ۵۱ فا ٦۰ سال -[ ] ٦۱ و بیشتر

۲. جنسیت شما چیست؟

-[ ] مرد -[ ] زن

۳. شما به کدام دانشکده در دانشگاه تعلق دارید؟

-[ ] فنی مهندسی -[ ]علوم پایه -[ ]روانشناسی -[ ]دامپزشکی -[ ]حقوق -[ ]دانشکده های دیگر:

٤. آیا با زبان انگلیسی آشنایی دارید؟

-[ ] بله، شما تا چه حد با زبان انگلیسی آشنایی دارید؟

-[ ] مبتدی -[ ]متوسط -[ ] پیشرفته

-[ ] خیر

۵. آیا در حال حاضر امکان استفاده از تکنولوژی (مثلا تلفن همراه) را دارید؟

-[ ] بله، شما چه دستگاه (های) همراه دارید؟

-[ ] موبایل -[ ]تبلت -[ ] لپتاپ -[ ]دستگاه های دیگر:

-[ ] خیر

٦. آیا از دستگاه (های) همراه خود برای یادگیری واژگان استفاده می کنید؟

-[ ] بله، کدام زبان را یاد می گیرید؟

-[ ] انگلیسی -[ ]آلمانی -[ ]فرانسه -[ ]اسپانیولی -[ ]روسی -[ ]چینی -[ ]زبان(های) دیگر:

-[ ] خیر

۷. آیا از قلم و کاغذ برای یادگیری واژگان استفاده می کنید؟

-[ ] بله، کدام زبان را یاد می گیرید؟

-[ ] انگلیسی -[ ]آلمانی -[ ]فرانسه -[ ]اسپانیولی -[ ]روسی -[ ]چینی -[ ]زبان(های) دیگر:

-[ ] خیر

۸. آیا تا به حال از یک برنامه کاربردی برای یادگیری واژگان در دستگاه (های) همراه خود استفاده کرده اید؟

-[ ] بله، تقریبا چه مدت پیش؟ لطفا به عنوان هفته ها، ماه ها یا سال ها (به صورت مناسب) لیست کنید.

-[ ]کمتر از۱هفته پیش -[ ] بیشتر از۱هفته پیش -[ ] کمتر از ۱ ماه پیش -[ ] بیشتر از۱ ماه پیش

-[ ]زمان(های) دیگر:

-[ ] خیر

۹. به طور کلی، آیا شما از این تجربه برای یاد گیری کلمات به وسیله تکنولوژی لذت بردید؟

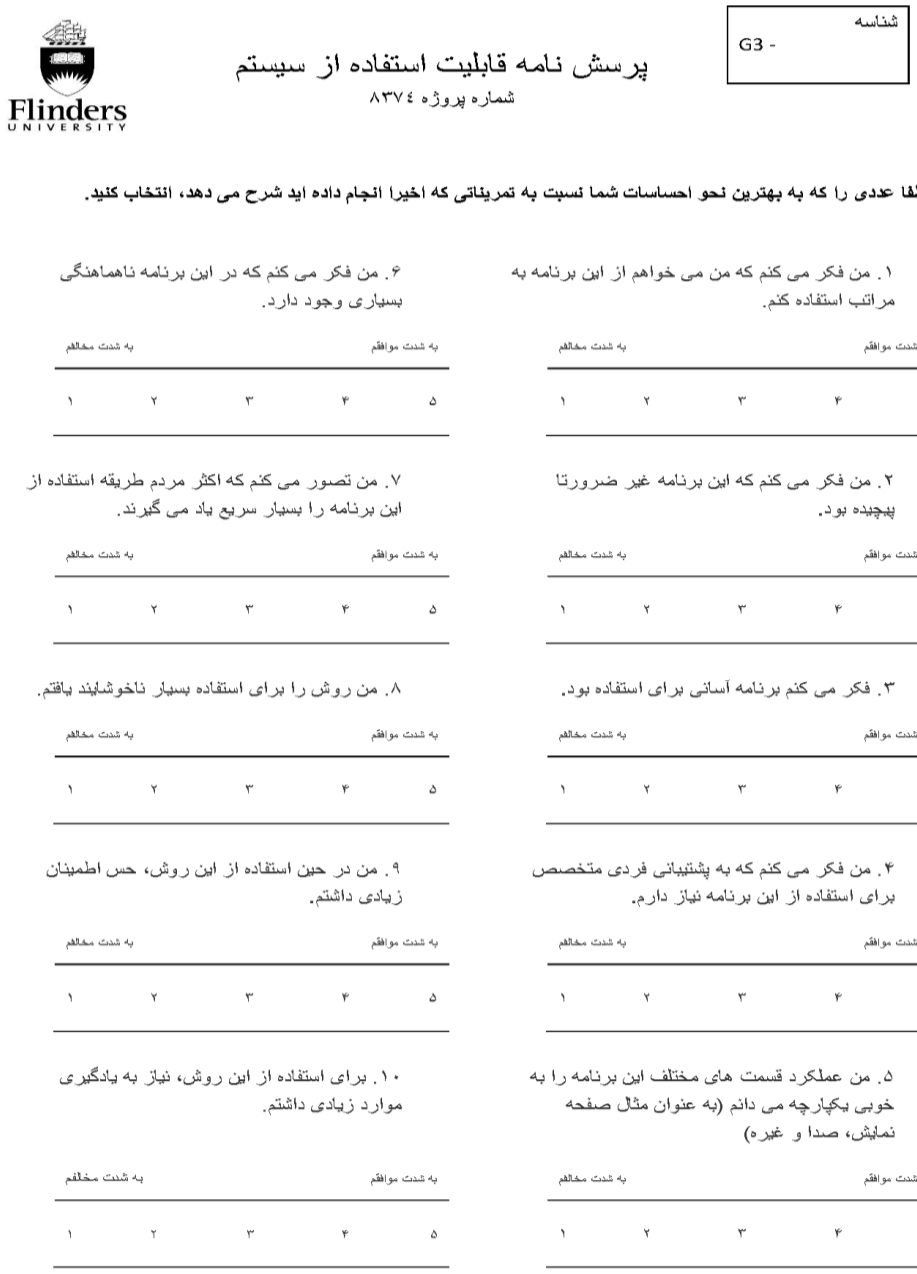
-[ ] بله

-[ ] خیر، چرا نه؟

دراینجا پرسشنامه پس زمینه تکمیل شده است. لطفا برگه را به مسوّل آزمایش بازگردانید.

Figure 47. Background questionnaire – Persian

VI. Persian SUS Questionnaire



شناسه
G3 -

Flinders UNIVERSITY

پرسش نامه قابلیت استفاده از سیستم
شماره پروژه ۸۳۷٤

لطفا عددی را که به بهترین نحو احساسات شما نسبت به تمریناتی که اخیرا انجام داده اید شرح می دهد، انتخاب کنید.

۱. من فکر می کنم که من می خواهم از این برنامه به مراتب استفاده کنم.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۲. من فکر می کنم که این برنامه غیر ضرورتا پیچیده بود.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۳. فکر می کنم برنامه آسانی برای استفاده بود.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۴. من فکر می کنم که به پشتیبانی فردی متخصص برای استفاده از این برنامه نیاز دارم.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۵. من عملکرد قسمت های مختلف این برنامه را به خوبی یکپارچه می دانم (به عنوان مثال صفحه نمایش، صدا و غیره)

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۶. من فکر می کنم که در این برنامه ناهماهنگی بسیاری وجود دارد.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۷. من تصور می کنم که اکثر مردم طریقه استفاده از این برنامه را بسیار سریع یاد می گیرند.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۸. من روش را برای استفاده بسیار ناخوشایند یافتم.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۹. من در حین استفاده از این روش، حس اطمینان زیادی داشتم.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخالفم

۱۰. برای استفاده از این روش، نیاز به یادگیری موارد زیادی داشتم.

به شدت موافقم ۵ ۴ ۳ ۲ ۱ به شدت مخلفم

Figure 48. SUS questionnaire – Persian

VII. Traditional P&P Booklets

Persian KWM Training Booklet

شماره پروژه ۷۲۸۹

روش یادگیری حافظه‌محور

۱ . مقدمه

روش کلیدواژه (keyword method) برای یادگیری و یادآوری معنی کلمات جدید طراحی شده است. این روش به شما کمک می کند تا اطلاعات جدید را به آنچه از قبل می دانید ربط دهید و به این صورت در یادآوری این اطلاعات در آینده کمک می کند. در اصل ، این روش با ایجاد پیوندهای جدید به دانش (اطلاعات) موجود شما، امکان استفاده از این پیوندها را هنگام بازیابی اطلاعات (جدید) از حافظه را ممکن می سازد.

۲ . روش کلیدواژه

در روش کلیدواژه، برای یادگیری کلمه انگلیسی nun ، ابتدا معنی آن را در فارسی پیدا می کنیم:

کلمه انگلیسی : Nun

معنی کلمه: راهبه

اکنون شما بعد از خواندن معنی کلمه می توانید ازروش کلیدواژه بر طبق مراحل زیر استفاده کنید تا بین کلمه جدید«nun» و معنی آن «راهبه» پیوندی برقرار کنید.

این پیوند جدید است که کمک می‌کند این کلمه در حافظه شما ماندگار شود .

روش کلیدواژه شامل ۲ مرحله است.

مرحله ۱ : انتخاب کلیدواژه

اولین مرحله برای یادگیری کلمه جدید این است که سعی کنید کلمه دیگری راپیدا کنید که از لحاظ آوایی یا نوشتار شبیه کلمه جدید انگلیسی (nun) است. این کلمه، کلمه ای فارسی است که شما آن را خوبی می شناسید. همچنین می تواند از کلمه ای از زبان دیگری باشد.

این کلمه نیاز به معنای مشخص دارد. یعنی کلمه ای است که می توانید آن را ببینید و لمس کنید .

این کلمه که از لحاظ آوایی شبیه بخشی از کلمه جدید است، کلیدواژه (keyword) نام دارد. دلیل این نام گذاری این است که این کلمه «کلید یادآوری» است که شما را قادر می سازد معنی کلمه جدید انگلیسی را به یاد بیاورید.

حال به دنبال یک کلمه فارسی باشیم که بخشی از / شبیه به کلمه جدید (nun) باشد. برای مثال کلمه «نان».

مرحله ۲ : مرحله تصویرسازی

تصویری (عکسی) در ذهن می سازیم. این مرحله شامل ایجاد یک تصویر در ذهن شما (یک تصویر ذهنی) است. این تصویر می تواند مانند یک کتاب تصویری یا یک عکس باشد ، یا می تواند یک کلیپ ویدیویی یا یک انیمیشن باشد.

نکته مهمی که درساخت این تصویر باید لحاظ شود این است که اطمینان حاصل کنید که این تصویر معنی کلمه «راهبه» و کلیدواژه «نان» را به روشی به یاد ماندنی یا غیرمعمول پیوند می دهد ، به طوری که وقتی به کلیدواژه نگاه می کنید ، معنی کلمه نیز به یادتان می آید.

Figure 49. Instruction booklet page 1 – Persian

تصویر = معنی + کلید واژه

نکته مهمی که باید در مثال حاضر در نظر بگیرید این است که معنی کلمه «راهبه» در تصویر به راحتی مشخص باشد. به همین دلیل ما راهبه را در تصویر زیر بزرگتر از نان نشان داده ایم:

به خاطر داشته باشید:

۱. تصویر باید ساده باشد و جزییات در آن کم باشد.

۲. تصویر معنی (راهبه) باید بزرگ تر باشد و تصویر کلید واژه (nun) باید کوچک باشد.

۳. در صورت امکان، تصویرعجیب و غریب، خنده دار یا غیر معمول باشد.

Figure 50. Instruction booklet page 2 – Persian

Persian Learning Booklet

کلمه انگلیسی	معنی	واژه کلیدی (شباهت ظاهری یا صوتی)
gambol	جست و خیز	گامبو

لطفا تا زمانی که از شما خواسته نشده برگه را بر نگردانید.

Figure51 . Learning booklet – Persian

Persian Testing Booklet

Flinders UNIVERSITY

پاسخ نامه

1TWS1

شماره پروژه ۸۳۷٤

شناسه
G1 -

کلمه انگلیسی متناسب با معنی انگلیسی آن را در ستون مربوطه را بنویسید. اگر کاملاً به معنای یک کلمه خاص اطمینان ندارید ، اما فکر می کنید شانس درست حدس زدن آن را دارید ، آنچه را که فکر می کنید بنویسید.
فقط وقتی که هیچ ایده ای برای حدس کلمات ندارید، جای جواب را خالی بگذارید. از ستون سوم برای نوشتن هر چیزی که به خاطر دارید در رابطه با کلماتی که نمی توانید یادآوری کنید یا مطمئن نیستید استفاده کنید.

کلمات انگلیسی	معنی کلمات	هر چه به خاطر می آورید
mortal		
quarter		
verse		
morality		
clergy		
idol		
charity		
lunatic		
vein		
fertility		
loyalty		
	برگه رای	
	لال	
	بسته	
	نوجوان	
	کسوف	
	جراحی	
	افسانه	
	پشم	
	سردخانه	
	طعمه	
	اشتباه	

Figure 52. Testing booklet – Persian

VIII. SBREC Approval Notice

Siamak Mirzaei

From: Human Research Ethics
Sent: Tuesday, 18 June 2019 4:12 PM
To: Siamak Mirzaei; Trent Lewis; Mirella Wyra; Brett Wilkinson
Subject: 8374 ETHICS approval notice (18 June 2019)
Attachments: 8374 application (31 May 2019).pdf; 8374 Conditional approval response (7 June 2019); 8374 Conditional ethics approval notice (5 June 2019).pdf; 8374 CAR - ADDITIONAL INFORMATION Requested (17 June 2019).pdf; RE: 8374 Conditional approval response (7 June 2019)

Importance: High

Dear Siamak,

Your conditional approval response for project 8374 was reviewed by the interim Chairperson of the Social and Behavioural Research Ethics Committee (SBREC) and was **approved.** The ethics approval notice can be found below.

APPROVAL NOTICE

Project No.:	**8374**		
Project Title:	Evaluating the Efficacy of Technology to Improve Vocabulary Learning		
Principal Researcher:	Mr Siamak Mirzaei		
Email:	Mirz0015@flinders.edu.au		
Approval Date:	18 June 2019	Ethics Approval Expiry Date:	**31 December 2023**

The above proposed project has been **approved** on the basis of the information contained in the application, its attachments and the information subsequently provided.

RESPONSIBILITIES OF RESEARCHERS AND SUPERVISORS

1. **Participant Documentation**
   Please note that it is the responsibility of researchers and supervisors, in the case of student projects, to ensure that:
   - all participant documents are checked for spelling, grammatical, numbering and formatting errors. The Committee does not accept any responsibility for the above mentioned errors.
   - the Flinders University logo is included on all participant documentation (e.g., letters of Introduction, information Sheets, consent forms, debriefing information and questionnaires – with the exception of purchased research tools) and the current Flinders University letterhead is included in the header of all letters of introduction. The Flinders University international logo/letterhead should be used and documentation

Figure 53. SBREC approval email – page 1

should contain international dialling codes for all telephone and fax numbers listed for all research to be conducted overseas.

- the SBREC contact details, listed below, are included in the footer of all letters of introduction and information sheets.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 'INSERT PROJECT No. here following approval'). For more information regarding ethics approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au.

2. Annual Progress / Final Reports

In order to comply with the monitoring requirements of the *National Statement on Ethical Conduct in Human Research 2007 (updated 2018)* an annual progress report must be submitted each year on the **18 June** (approval anniversary date) for the duration of the ethics approval using the report template available from the Managing Your Ethics Approval web page.

Please note that no data collection can be undertaken after the ethics approval expiry date listed at the top of this notice. If data is collected after expiry, it will not be covered in terms of ethics. It is the responsibility of the researcher to ensure that annual progress reports are submitted on time; and that no data is collected after ethics has expired.

If the project is completed *before* ethics approval has expired please ensure a final report is submitted immediately. If ethics approval for your project expires please either submit (1) a final report; or (2) an extension of time request (using the modification request form).

First Report due date:	**18 June 2020**
Final Report due date:	**31 December 2023**

Student Projects
For student projects, the SBREC recommends that current ethics approval is maintained until a student's thesis has been submitted, assessed and finalised. This is to protect the student in the event that reviewers recommend that additional data be collected from participants.

3. Modifications to Project

Modifications to the project must not proceed until approval has been obtained from the Ethics Committee. Such proposed changes / modifications include:

- change of project title;
- change to research team (e.g., additions, removals, researchers and supervisors)
- changes to research objectives;
- changes to research protocol;
- changes to participant recruitment methods;
- changes / additions to source(s) of participants;
- changes of procedures used to seek informed consent;
- changes to reimbursements provided to participants;
- changes to information / documents to be given to potential participants;
- changes to research tools (e.g., survey, interview questions, focus group questions etc);
- extensions of time (i.e. to extend the period of ethics approval past current expiry date).

To notify the Committee of any proposed modifications to the project please submit a Modification Request Form available from the Managing Your Ethics Approval SBREC web page. Download the form from the website every time a new modification request is submitted to ensure that the most recent form is used. Please note that extension of time requests should be submitted prior to the Ethics Approval Expiry Date listed on this notice.

Change of Contact Details
If the contact details of researchers, listed in the approved application, change please notify the Committee so that the details can

2

Figure 54. SBREC approval email – page 2

be updated in our system. A modification request is not required to change your contact details; but would be if a new researcher needs to be added on to the research / supervisory team.

4. Adverse Events and/or Complaints

Researchers should advise the Executive Officer of the Ethics Committee on 08 8201-3116 or human.researchethics@flinders.edu.au immediately if:

- any complaints regarding the research are received;
- a serious or unexpected adverse event occurs that effects participants;
- an unforeseen event occurs that may affect the ethical acceptability of the project.

Kind regards
Andrea

Andrea Mather and Rae Tyler
Executive Officers, Social and Behavioural Research Ethics Committee
Research Development and Support
P: (+61-8) 8201 3116 | andrea.mather@flinders.edu.au
P: (+61-8) 8201 7938 | rae.tyler@flinders.edu.au

Flinders University
Sturt Road, Bedford Park, South Australia, 5042
GPO Box 2100, Adelaide, South Australia, 5001

http://www.flinders.edu.au/research/researcher-support/ebi/human-ethics/human-ethics_home.cfm

Flinders Proactively supporting our Research

Figure 55. SBREC Approval email – page 3

IX. List of Word-Pairs

Word-set 1

Table 20. Word-set 1 word-pairs

No	Word	Meaning	Keyword[1]
1	mortal	فانی	مرتاز /ˈmɔːt(ə)z/
2	quarter	بخش	کارتر / ˈk(w)ɔːtər/
3	verse	شعر	ور / vəːr /
4	morality	اخلاق	مارال / məˈral/
5	clergy	روحانی	کرجی / ˈkaraːdʒi /
6	idol	بت	آي دلم /ˈʌɪd(ə)l/
7	charity	خیریه	چریدی؟ /ˈtʃarɪdi/
8	lunatic	دیوانه	لونه /ˈluːnə/
9	vein	رگ	وین رونی /veɪn ruːni/
10	fertility	باروری	فرتی فرتی /fəˈtɪ fəˈtɪ/
11	loyalty	وفاداري	رویا /ˈrɔɪə/
12	ballot	برگه رای	بلوط /ˈbalut/
13	mute	لال	میو /mjuː/
14	wad	بسته	وادار /wɒdɒr/
15	adolescent	نوجوان	سن عادل /s(ə)nɛ adəˈlɛ/
16	eclipse	کسوف	کلیپس /klɪps/
17	surgery	جراحی	سرجری /ˈsar(ə)ːdʒ(ə)ri/
18	legend	افسانه	لجن /ˈladʒan/
19	fur	پشم	فر /fəː/

[1] Phonetic symbols are written for demonstration purposes only

20	morgue	سردخانه	/marg/ مرگ
21	bait	طعمه	/beɪt/ بیت
22	blunder	اشتباه	/ˈblʌnd/ بلوند

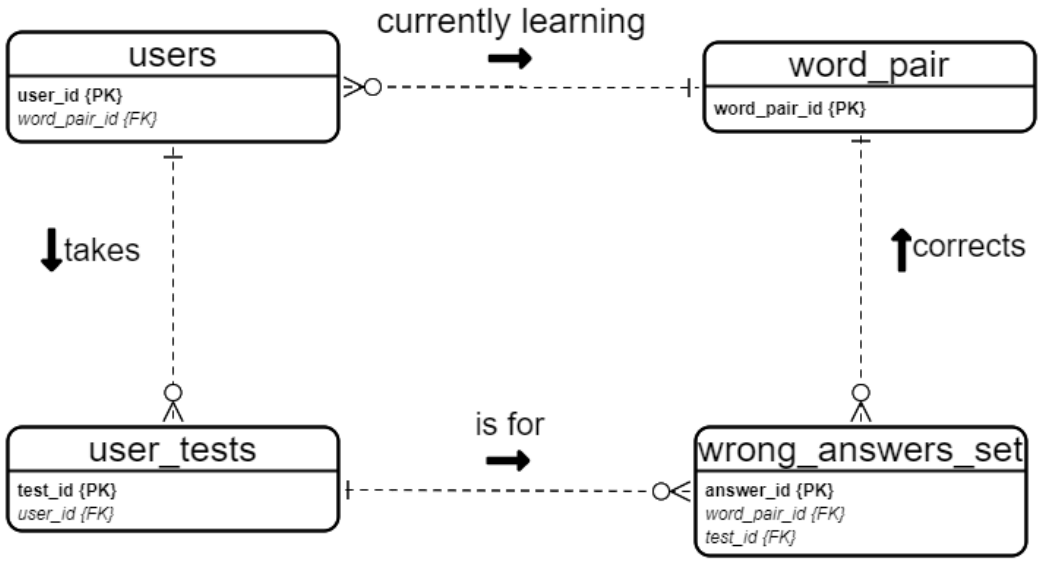
Word-set 2

Table 21. Word-set 2 word-pairs

No	Word	Meaning	Keyword
1	alimony	نفقه	/ˈʌlməni/ آلمانی
2	gambol	جست و خیز	/ˈgambu:/ گامبو
3	bachelor	مجرد	/ˈbatʃəlˈər/ بچه لر
4	drudgery	خرحمالی	/ˈdrudgəri/ درودگری
5	felon	گناهکار	/ˈfɛlʌn/ فلان
6	rage	خشم	/rag/ رگ
7	source	منبع	/sɔ:s/ سس
8	glimpse	نگاه	/glɪm/ گلیم
9	decade	دهه	/ˈdɛhkade/ دهکده
10	pollution	آلودگی	/pəˈl/ پول
11	vessel	رگ	/ˈvɛsʌl/ وصال
12	gleam	درخشش	/glɪm/ گلیم
13	rival	رقیب	/ˈrɛvʌl/ روال
14	ambush	کمینگاه	/ˈamubʊʃ/عموبوش
15	dilemma	دوراهی	/dɛˈlɛmə/ دل ما
16	scowl	آدم اخمو	/ˈəskɔ:l/اسکل
17	vermin	آفات	/ˈvarʌmɪn/ ورامین
18	wail	گریه و زاري	/wʌweɪlʌ/ واویلا
19	symbol	نماد	/ˈsambɔ:l/ سمبل
20	collapse	خرابه	/karafs/ کرفس
21	bigamy	دو همسري	/ˈbɪgəmi/ بی غمی

22	monarch	پادشاه	مونا /ˈmɒnə/

X. ERD and Logical Model



Logical Model

users(user_id, word_pair_id, email, password, salt, fullname, test_type, learn_atmp, exp_type)
PK user_id
FK word_pair_id references word_pair(word_pair_id)

word_pair(word_pair_id, wordset, target_word, word_meaning, keyword, word_type, syllable, word_order, demo, tutorial)
PK word_pair_id

user_tests(test_id, user_id, test_date, user_answers, test_code, duration)
PK test_id
FK user_id references users(user_id)

wrong_answers_set(answer_id, word_pair_id, test_id, en_word, fa_word)
PK answer_id
FK word_pair_id references word_pair(word_pair_id)
FK test_id references user_tests(test_id)

Figure 56. ERD and logical model

In Figure 56, in the ERD diagram, each entity is represented by a separate box; the primary and foreign keys are shown in bold and italics in the diagram and with '{PK}' and '{FK}' in relations, respectively. The WRONG_ANSWER_SETS was utilised to check and compare the user answers to help with data analysis purposes.

XI. Award and Grants

The following grants and awards were received for the duration of the candidature:

1. FUSA Development Grant, Flinders University, Adelaide, Australia, 2018
2. CSE HDR Student International Conference Travel Grant, Flinders University, Adelaide, Australia, 2018
3. Flinders University Overseas Field Trip Grant, Flinders University, Adelaide, Australia, 2019
4. CSE HDR Student International Conference Travel Grant, Flinders University, Adelaide, Australia, 2019
5. FUSA Development Grant, Flinders University, Adelaide, Australia, 2018
6. Flinders University DocFest 2020 Best HDR Student Poster Presentation, 2020
7. Flinders University 3 Minute Thesis (3MT) Heat 2 Runner-Up & Semi-Finalist, 2020
8. FURS, Flinders University, Adelaide, Australia, 2019 – 2021
9. APR Internship, Makers Empire, Adelaide, Australia, 2021
10. CSE HDR Student International Conference Travel Grant, Flinders University, Adelaide, Australia, 2021