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"The Implementation of Digital Learning Technology in the Teaching of EFL Vocabulary"

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List of abbreviations

CEFR – common European frame of reference for languages
CALL - computer-assisted language learning
DPT - delayed post-test
EFL - English as a foreign language
GPS - Global Positioning Systems
L1 – first language
L2 – second language
LTM - long-term memory
MALL – mobile-assisted Language Learning
m-Learning – mobile learning
MTM – medium-term memory
M-WM - multicomponent working memory
SLA – second language acquisition
SLL/s – second language learner/s
STM - short-term memory
WM - working memory
VBS - Vienna Bilingual Schooling System

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1. Introduction

From the decidedly modest beginnings of the ostensibly mobile, brick-like contraptions of the 1980s, today's mobile phones have become truly portable, powerful, and practicable handheld microcomputers with advanced operating systems that enable a new world of functionality (Godwin-Jones 2011: 3). In no other area are these developments more relevant than in the area of education, and running in parallel with a trend towards ever-improving functionality and a continually expanding range of features offered by mobile technologies over the past 20-30 years has been a steadily increasing volume of language research literature, championing the instructional benefits and advantages of newly-enabled pedagogical paradigms and advocating for the increased use of mobile technology in the learning of foreign languages (Burston 2014a, 2015; Brown, Campbell & Ling 2011; Sharples 2010; Kukulska-Hulme 2009). This relatively young and specialised area of language research known as *Mobile-assisted Language Learning* (MALL), although arguably still in its early phases (Burston 2014b: 344) and still a decidedly niche subject (Burston 2014a: 115), is an area of *second language acquisition* (SLA) research that is currently garnering an increasing amount of interest from researchers as mobile technologies continue to expand their influence and push the technological boundaries of what is pedagogically possible (Kukulska-Hulme 2009; Duman, Orhon & Gedik 2014).

Combining extensive accessibility, increased functionality, and reduced cost, mobile phone ownership in the United States now far surpasses desktop and laptop ownership, with 96% of US adults now owning a mobile phone (Pew Research Center 2019). Specifically concerning the situation in Austria, a recent extensive study conducted in the state of Upper Austria on the relationship between young people and digital media concluded that 92% of young people between the ages of 11 and 18 in the state now have access to a mobile phone (Education Group 2019: 95). Data such as this strongly supports the conclusion that mobile, digital instruction, will likely play a supporting role in educational models of the future (Thomas, O'Bannon & Bolton 2013: 304-305).

With new mobile technologies boasting intelligent user-interfaces, large, high resolution touch-screens that competently display and allow interaction with content, and processing speeds that rival modern low-end laptop and desktop computers, an individualised, engaging, convenient, contextually-aware, truly portable *anytime*, *anywhere* learning environment is now a reality for the majority of language learners in developed countries (Godwin-Jones 2011: 2; City College Southampton 2005: 5). Mobile phones are now powerful enough, affordable enough, and their

accompanying technology advanced to a level, to render their consideration as being fit only for communication and entertainment purposes somewhat spurious, and that manifests their viability as valuable language learning tools that should not be overlooked in the field of education (Duman, Orhon & Gedik 2014; Kukulska-Hulme & Shield 2008). Indeed, it has been remarked by Tony Bates, in the forward to the third edition of Beetham and Sharpe's *Rethinking Pedagogy for a Digital Age*; "I predict that nearly all teaching in the future will involve at least some kind of digital learning" (Beetham & Sharpe 2020: 18), suggesting that digital technologies will, in one way or another, become ubiquitous in the educational models of the future, and opening up the question as to what extent MALL can play a part.

Partly in reaction to the present ubiquity of communications technologies in almost all areas of modern society and their general importance for both the European and Austrian economies (Bruneforth et al. 2015: 95), and partly in recognition of the development of a new generation of learners whose "lives are unimaginable without their digital devices, skills and connectivity" (Beetham & Sharpe 2020: 1), or *digital natives,* as the present generation of young learners are often termed (Crăciun 2019: 90; Thompson 2013: 12), organisations such as the European Union, and the OECD have begun to focus attention on what is termed *digital competence* in their recommendations for frameworks intended to guide education curriculum design (Ilomäki, Kantosalo & Lakkala 2011). In 2010 for instance, the European Union laid out a framework of eight key competencies considered essential for lifelong learning and the creation of a well-functioning knowledge-based society, in which *digital competence* appeared fourth on the list (European Union 2010: 2). Yet, despite this shift of attention towards the recognition of the importance of digital technology in today's society and the possible advantages of implementation in education, the use of digital technologies in the Austrian classroom has been described as being far behind what could be expected, and in a European-wide comparison, Austria currently finds itself above only Luxemburg and Poland in terms of digital media use in the classroom (Bruneforth et al. 2015: 97-98).

This research paper, therefore, will investigate the efficacy of a MALL vocabulary learning intervention in an Austrian high school context as part of a standardised *English as a foreign language* (EFL) curriculum-based language teaching course. The study will utilise a relatively small number of second language learners to investigate how the implementation of technological solutions contribute in such a context to the achievement of objectively measurable learning outcomes. Both quantitative and qualitative methods will be used in a mixed-methods design to ascertain whether the use of a freely available mobile vocabulary

learning application (Memrise) increases learning outcomes with respect to *paper-based*, or what are commonly referred to as *traditional* learning methods (Lin & Lin 2019: 3), and to assess participant perceptions and experiences relating to the integration and use of such interventions as part of school-level curriculum-based EFL programs. Medium-term and *delayed post-test* (DPT) learning outcomes will be measured with specially designed vocabulary tests designed to test the extent of semantic and conceptual consolidation in *long-term memory* (LTM), and a participant questionnaire will be administered post-test to gather both quantitative and qualitative data on participant learning behaviour, attitudes and perceptions, and the readiness of participants to integrate mobile technology into their learning activities, in order to gain insight into how such technologies might be profitably integrated into EFL language learning curricula in a high-school context.

It is becoming difficult to ignore the fact that digital natives are increasingly embracing the portability and functionality of their mobile devices in the attaining of their learning goals (Sage, Krebs & Grove 2019: 461; Rideout, Foehr & Roberts 2010: 2). An area in which large strides towards this new digital learning reality have already been made is that of higher education, where online coursework is now a staple of most university courses and digital course materials are increasingly offered (Margaryan, Bianco & Littlejohn 2015; Rainie et al. 2012). The current generation of *digital natives* are thus becoming more and more likely to turn to digital means of accessing and interacting with learning materials than at any time in the past (Sage, Krebs & Grove 2019: 464).

This newly emergent paradigm for the mobile presentation and consumption of digital information, at *any time* and in *any place* that is convenient to the learner, is a direct result of the confluence of three technological strands that are currently interacting with an accompanying societal shift in the ways in which individuals utilise technology (Godwin-Jones 2011, 2007). A confluence of ambient computing, ambient communication, and the development of intelligent user interfaces are all technological factors that are converging to produce a flurry of creativity and development in the mobile educational sector (Sharples et al. 2002), and this in turn is fuelling a significant increase in the interest and attention of the language research community, as can be referenced by the growth in published studies focusing on MALL implementations both in the truly autonomous, mobile, out-of-class sense, and also as complementary components of existing language teaching programs (Lin & Lin 2019; Burston 2015; Duman, Orhon & Gedik 2014).

Researchers and language teaching practitioners alike are becoming more aware of the advantages offered by *mobile learning* (m-Learning), the features that are afforded by modern mobile technology (Crăciun 2019: 101), and the advantages that could potentially be made available to learners (Chen, Chen & Yang 2019). Learners are offered a broad range of possibilities in terms of facilitating their *second language* (L2) learning, tailoring learning materials, and controlling the learning process to suit their individual requirements (Klopfer et al. 2012; Kukulska-Hulme 2006; Motteram & Sharma 2009; Kiernan & Aizawa 2004). Learners can enjoy the convenience of instant and ubiquitous access to learning materials, increasing motivation and also the time available to learn (Cavus & Ibrahim 2009: 80-81) and are afforded abilities such as adjusting the difficulty level of materials to suit their own level of proficiency (Deris & Shukor 2019: 135), varying modes of learning (Mayer 2001), and learning at the speed they desire (Hung et al. 2012). Ease of accessibility and use of mobile technologies have thus been shown to positively effect learner attitudes towards the use of MALL in SLA (Al-Emran, Elsherif & Shaalan 2015; Al-Said 2015), with learners generally reporting positive attitudes towards the practicality and convenience afforded by the use of mobile technologies in the learning of vocabulary specifically (Deris & Shukor 2019; Basal et al. 2016; Soleimani, Ismail & Mustaffa 2014; Kim et al. 2013). Results such as these suggest that learners may also be supportive of the integration of MALL into curriculum-based EFL courses.

In addition, m-Learning, with its ability to deliver context sensitive and individually tailored learning materials *anytime* and *anywhere* to the learner (Storz et al. 2012), opens up the possibility of creating unique learning environments particularly suited to use in educational contexts (Klopfer et al. 2012), which are able to leverage differing learning paradigms and take advantage of differing theories of learning. Mobile phones can now be viewed as powerful language learning tools which present both language learners and language practitioners with new possibilities that demand research attention to fully describe, understand, and take advantage of possibilities in the maximisation of efficiency and the streamlining of modern language learning (Kukulska-Hulme 2006, 2009; Lin & Lin 2019; O'Malley et al. 2005).

Potential, therefore, to utilise the benefits and opportunities presented specifically for the learning of EFL vocabulary as part of curriculum-based EFL programs has not gone unnoticed in the MALL research community, and extensive reviews of the existing literature have shown that most published studies on MALL implementations to-date have investigated the utilisation of various aspects of MALL in *vocabulary acquisition* specifically (Lin & Lin 2019; Burston

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2015). Learning vocabulary is regarded as one of the principle challenges with which the learner of a foreign language is faced (Lin & Lin 2019: 2; Hulstijn & Laufer 2001: 540), and the maximising of efficiency in this area and the helping of learners in the notable task of learning the thousands of vocabulary items necessary to achieve competency (Hulstijn & Laufer 2001: 540) can now be aided through ubiquitous and instant access to individualised, relevant, and authentic materials. Mobile technologies now present a very real opportunity for learners to maximise the time available to them and streamline the learning process (Sung, Chang & Liu 2016). Hence, language researchers are increasingly realising the potential that mobile technology offers to those seeking to learn a foreign language, and a growing body studies suggest that the use of MALL in the learning of foreign languages and in particular in the learning of vocabulary, could well lead to innumerable benefits for learners and language teachers alike (Lin & Lin 2019; Basoğlu & Akdemir, 2010; Cavus & Ibrahim, 2009; Levy & Kennedy, 2005; Song, 2008; Thornton & Houser, 2005).

However, notwithstanding the predominantly positive outlook that is exemplified by much of the published literature to date in the research area, it has been noted that there is still a lack of research on MALL applications for learning vocabulary within an EFL context (Deris & Shukor 2019: 129). It has also been noted that there is a lack of research in general that compares paper-based learning methods to their digital counterparts (Sage, Krebs & Grove 2019: 464), raising questions concerning objective measurements of the efficacy of MALL vocabulary learning interventions in an EFL context. There has also been a distinct lack of studies that have looked at the best ways to utilise new mobile technologies and harness their purported advantages (Sung, Chang & Liu 2016: 253).

The embracing of mobile technology in the modern-day language classroom can only become reality if it can be definitively shown to provide reliable and objectively quantifiable positive learning outcomes (Burston 2015: 16). It has also been noted that "it is of great necessity to clarify the cause and effect relationship between mobile technology interventions and L2 vocabulary word retention" (Lin & Lin 2019: 8). More research is clearly needed, both to confirm the efficacy of the implementation of MALL interventions in the EFL classroom, and to address the pedagogical challenges related to such interventions.

The following research questions will be examined and discussed in this research paper along with their relevant sub-questions;

1. What is the effect in terms of learning outcomes when using a MALL vocabulary learning application, on the L2 English vocabulary knowledge of EFL learners in comparison to using offline paper-based learning methods?

2. What were the individual perceptions and learning experiences of participants?

    a. Where, when, and for how long did participants, in both the experimental and the control groups, engage with the learning materials?

    b. What did participants like/find useful/dislike about using the MALL application?

    c. What would participants change about the application?

3. What are the attitudes and perceptions of participants concerning MALL vocabulary learning interventions in the EFL classroom and would they support future integration?

It has been said that "[e]ducation has been simultaneously criticised for being too slow to adopt new technologies, and too quick to jump on the latest bandwagon" (Beetham & Sharpe 2020: 3). This rather troubled relationship with technology seems set to change in the future as language teachers are, now more than ever, able to take advantage of a thoroughly unique classroom situation in which their students can normally be expected to own and to have on their person, devices that can take advantage of new pedagogical paradigms (Johnson et al. 2011: 9). The opportunity for new paradigms of language learning to become a standard feature of any language learning curriculum, allowing students autonomy and self-direction in their learning and giving them independent access to a language course's resources *anytime* and *anywhere*, has most certainly presented itself (Gardner & Miller 1999).

The current omnipresence of technology in society is the direct result of wider societal change that is being driven by forces at the heart of the information age (Castells 1996). With deep learning currently transforming computing (Steinbrecher et al. 2019) and subsequently revolutionising natural language processing (Wu et al. 2016), and with predicted further advances in computer technology and the commercial availability in the near future of quantum computers (Gyongyosi & Imre 2019), the functionality and capabilities of current mobile technologies can be expected to increase and to broaden their influence, especially in the sphere of educational technology dedicated to language learning. Accompanying these changes therefore, MALL looks set to become an increasingly important area of language learning

research and language pedagogy, thus cementing the importance of continuing research in the area. The current research study aims to add to the ongoing and lively discussion.

This research study is composed of 6 main sections including this introduction. Section 2 comprises a literature review which begins by defining MALL and outlining historical developments in the area before discussing major research findings and providing details of relevant pedagogical theories of learning relating to the learning of L2 languages through the use of mobile technologies. The section ends with a discussion of research concerns and briefly deals with the question of curricular integration and its challenges.

Section 3 provides a detailed discussion of vocabulary learning in general and discusses the major role that cognition and memory play in the process of vocabulary acquisition, the consolidation of meaning in LTM, and subsequent recall during language use. This section ends with a discussion of *vocabulary learning strategies* and vocabulary learning taxonomies before briefly introducing major research on flashcard use in vocabulary learning.

Section 4 outlines the methodology of a mixed-method vocabulary learning experiment carried out for this research study to test the efficacy of a MALL vocabulary learning intervention in an Austrian high-school EFL context. The experiment is contextualised and described in detail with justifications given for methodological decisions as they were taken in its implementation.

Section 5 describes the results of the experiment along with statistical analysis of the empirical data obtained and interpretation of qualitative data collected from a participant questionnaire administered following the experiment. The section ends with a short discussion of the limitations of the study and words of caution concerning the interpretation of the results.

Finally, section 6 provides a concluding discussion of results and their relation to hypotheses made on the grounds of insight gained from sections 2 and 3. Finally, suggestions for further research are given along with closing comments.

2. Mobile-assisted language learning – literature review

2.1. Defining mobile-assisted language learning

When attempting to define *mobile-assisted language learning* (MALL), careful attention must be paid to the pedagogical assumptions upon which any definition is based (O'Malley et al. 2005: 7). However, specifically from the point of view of the current research study, the question of language pedagogy forms a large part of the research questions with relation to learning outcomes and curricular integration, and therefore, as any definition of MALL that is used will guide later discussion, issues regarding the choice of a certain definition over and above others must be addressed.

Definitions of MALL can generally be regarded as falling into one of two broad categories depending upon the significance that is placed on either the learner or on the technology used (Burston 2014b). If *m-Learning* (mobile learning) (O'Malley et al. 2005: 6), is to be defined in a manner that focuses on the mobility of the physical device that is used in the act of learning, then it must be understood that the pedagogical assumptions that support this definition assume that m-Learning occurs as a result of the characteristics of the device. Consequently, this technological focus limits the range of activities that can be categorised under such a definition to learning activities that occur through, and therefore as a result of the characteristics of the device used, and has the effect of concentrating any subsequent discussion onto questions of a technological nature. This naturally detracts attention from learner-centred considerations such as pedagogical factors.

KuKulska-Hulme & Shield utilise just such a technocentric definition in an early paper;

> For our purposes then, 'mobile learning' refers to learning mediated via handheld devices and potentially available anytime, anywhere. (Kukulska-Hulme & Shield 2008: 273)

This technology-focused notion of m-Learning restricts possible learning activities that fall under the definition to those which are performed with the help of mobile, hand-held devices, while excluding other activities which are performed with the help of other technologies which may be physically stationary in nature, however, also offer learners the same kind of spatial and temporal flexibility offered by physically mobile devices.

When defining m-Learning, other researchers have also focused their definitions on the strictly mobile characteristics of the devices being used;

> The term mobile learning or in short M-Learning refers to the use of mobile and handheld IT devices, such as mobile telephones, laptops, PDAs and tablet PC technologies, in training, learning and teaching. (Sarrab, Aldabbas & Elgamel 2012: 31)

As can be seen, by defining m-Learning as "the use of […] devices" (Sarrab, Aldabbas & Elgamel 2012: 31), the focus is taken away not only from other technologies that are not explicitly mobile yet also provide the learner with flexibility in their learning activities, but also from the reasons why such mobile interventions may be profitable from a pedagogical point of view, from the perspective of the learner and their personal learning goals. Kukulska-Hulme has since recognised the limitations of this stance;

> Early definitions of [m-learning], which focused predominantly on the attributes of mobile technology, have given way to more sophisticated conceptualisations suggesting that mobility is the central issue […]. This denotes not just physical mobility but the opportunity to overcome physical constraints by having access to people and digital learning resources, regardless of place and time. (Kukulska-Hulme 2010: 182)

An alternative approach to the definition of m-Learning results in definitions with a clear focus on the mobility and other characteristics of the language learner. In this way, a much broader definition is afforded, and a different set of pedagogical assumptions provided for. O'Malley et al. define m-Learning as;

> Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies. (O'Malley et al. 2005: 7)

This definition quite deliberately views mobility from the perspective of the learner instead of regarding it as a direct result of the characteristics of the technology. Thus, m-Learning does not take place simply as a result of "the use of mobile and handheld IT devices" (Sarrab, Aldabbas & Elgamel 2012: 31). Alternatively, learning is viewed as occurring when the learner themselves is mobile or chooses to make use of mobile technologies in the act of learning wherever they happen to be.

A learner-centred conception of MALL ultimately encompasses a view of the learner as active in the learning process and implies a certain measure of student-centred or student-managed learning as opposed to assuming a teacher-centred, or even device-centred paradigm. This definition is therefore accommodating to communicative, collaborative, learner-centred methodology, which is in keeping with the dominant language pedagogy of the last 40 years (Burston 2014a: 115), and clearly expresses the pedagogical direction that is likely to dictate the way forward for MALL as a language research area as the computer revolution blurs the boundaries between physical and purely informational reality still further (Kay 2007). Communicative, learner-centred conceptions of MALL such as this, stand in direct contrast to

the pedagogical assumptions that have underpinned the majority of MALL studies up until quite recently, that have been noted as being pedagogically constrained to teacher-centred, tutorial-focused, and behaviouristic approaches to language learning (Burston 2014a; Kulska-Hulme & Shield 2008).

It is therefore in the employment of mobile technology in the act of learning that the differentiation of m-Learning from other forms of learning such as e-Learning, which is concerned simply with the utilisation of any form of digital technology in the act of learning, is made (O'Malley et al. 2005), and that employment of mobile technology is something that is *done* by the learner. When MALL is viewed from this perspective, the picture that emerges concerning the learning that occurs becomes describable in a set of wholly different terminology. Learning is no longer as a result of short messaging services, or multimedia interventions, or other technological factors such as user-interfaces and touchscreens, instead, learning becomes describable in terms such as those depicted in the following graphic utilised by Traxler;
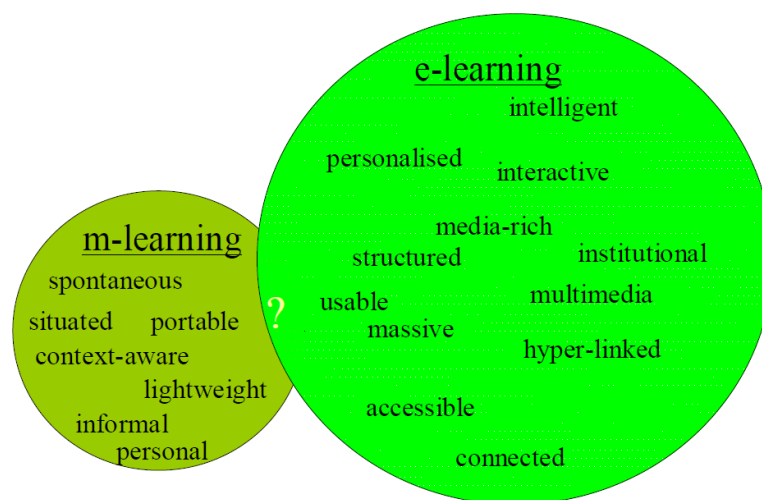
Figure 1: Traxler (2005) – m-Learning vs. e-Learning

Here, the concept of *learning* itself becomes context-aware, spontaneous, and can be seen as including characteristics focused on pedagogical concerns and learner-centred considerations. Further terms identified by Traxler that can now be added to this graphic due to the technological progress made since his original publication are indeed "connected, personalised, and interactive" (Traxler 2005: 264).

For the purposes of this thesis therefore, a view of MALL will be taken that is defined by learner-centred definitions such as those that have been given by Sharples, Taylor and Vavoula, who take the following stance;

> It is the learner that is mobile, rather than the technology […] interactions between learning and technology are complex and varied, with learners opportunistically appropriating whatever technology is ready to hand as they move between settings, including mobile and fixed phones, their own and other people's computers, as well as books and notepads. (Sharples, Taylor & Vavoula 2005: 3-4)

By regarding mobility as stemming from the learner, focus is shifted towards questions of interest such as pedagogical questions concerning learning outcomes, and why it is, pedagogically speaking, that one MALL implementation may result in positive learning outcomes or a positive learning experience, while another may not.

The following literature review will now be guided by a number of accompanying questions in order to focus the areas of interest to those most relevant to the current study, namely:

1) What is the current state of affairs in the area of MALL research?
2) What research evidence has been reported in the literature concerning the effects of the use of mobile technology on the effectiveness of teaching and learning vocabulary?
3) What research findings, if any, relate explicitly to the teaching and learning of vocabulary within the context of the EFL language learning classroom?

2.2. Historical overview

Notwithstanding the discussion above, a short historical overview of MALL studies will be given here and organised along a timeline mirroring the evolution of mobile technology itself in order to give a historical perspective as opposed to a pedagogical perspective. Although this may initially appear to directly contradict the discussion above, an overly technocratic focus has important implications only for the pedagogical assumptions underpinning the educational use of mobile devices. When viewing MALL historically however, a more accurate picture of the development of the research area is gained by treating the area itself as reactionary, for as technology has progressed, MALL research has followed.

2.2.1. Early speculations

Some of the earliest conceptualisations of the ways in which technology of the future might influence education came from the imagination of pioneering technologists working during the beginnings of the modern microprocessor revolution. Early adopters of computer technology with an interest in education such as Alan Kay, a Ph.D. student at the University of Utah, envisaged a future in which everyone would have access to small, hand-held mobile microprocessors that would serve as personal portals into a digital world of information for the sole purposes of education (Kay 1972; Kay & Goldberg 1977). In the concluding remarks of Kay's then science-fiction-like proposals for just such a device, he noted;

> We do feel that the pedagogical merits of teaching algorithmic thinking, having easy editing, etc. (all wrapped up in an environment which can go anywhere and can belong to everybody), are undeniable. […] Let's just do it! (Kay 1972)

However, for these theoretical speculations to become reality, a number of factors needed to fall into place, and progress in the area took rather longer than the "near future" (Kay 1972) initially predicted.

Technological advancements, such as the miniaturisation of components, improvements in microprocessor technology, and advances in computer memory technology were needed before such devices with the size and functionality of Kay's conceptual *Dynabook* could become feasible and have any significant impact on educational practice. Once the technology was in place however, and just as Kay had envisaged, "trends in miniaturisation and price reduction almost guarantee[d] that many of the notions discussed […] actually happen[ed]" (Kay 1972).

2.2.2. Early studies

Though the notion of digital, mobile, information-manipulating technology had been around at least since Kay's proposals in the 1970s, it was not until 1993 that a stage of technological development had been reached to allow hand-held, digital devices to become available to educational researchers in forms such as Apple's Newton (Hormby 2006). Researchers noted that, up until this point, "educational computing ha[d] taken place almost entirely in a context in which the computing [was] essentially regarded as a classroom-based or laboratory-based activity" (Fung, Hennessy & O'Shea 1998: 109). However, with the introduction of the Newton and personal digital assistants, the opportunity to take language learning out of the classroom had arrived. With rapid progress being made in the development of hardware and software, it

was clear that digital devices were breaking free of their physical limitations and becoming truly mobile.

As soon as mobile hand-held digital devices could be easily and cost-effectively obtained, researchers focused on the application of these technologies in educational contexts, and the first studies recognisable as MALL studies were published. These initial studies focused on *first language* learning (L1) English learners, and worked with early mobile technology, namely *personal digital assistants*, which offered basic word-processing capabilities (Schibeci & Kissane 1995; Fung, Hennessy & O'Shea 1998; Lewin et al. 2000). It was with the publication of these early studies that MALL began to distinguish itself from its older cousin *computer-assisted language learning* (CALL) by focusing on the *anytime, anywhere* element of m-Learning.

Regarding MALL's application to second language learning (L2), studies of the word-look-up behaviour of Japanese learners, who were then enthusiastically using portable pocket dictionaries to learn English, began to appear (Sharpe 1995; Yonally & Gilbert 1995; Weschler & Pitts 1999, 2000), and later with research interest sparked, studies from China and Taiwan reported on the language learning behaviour of Chinese learners and the advantages garnered from *anytime, anywhere* access to learning materials (Wang 2003; Liang et al. 2005; Deng 2006). These studies emphasised the advantages of being able to dip in and out of learning *wherever* and *whenever* the learner wished, thus highlighting the advantages of learner independence in the learning process (Burston 2015: 4).

As early micro-computers, personal digital assistants exhibited some of the functionality that we find in smartphones today and provided users with features such as basic computer-programming and wireless internet access (Burston 2014b: 345; Hormby 2006). In the early days of MALL research, personal digital assistants were the only option for researchers wishing to investigate features of mobile technology beyond basic cell-phone functionality, as mobile phone capabilities in the early 2000s were mostly restricted to simple voice and SMS messaging (Robertson et al. 2009; Burston 2014b: 345).

Pioneering personal digital assistant studies on L2 reading in an educational context, compared printed materials with digital presentation and all reported positive results (Zurita & Nussbaum 2004a, 2004b; Tan & Liu 2004). In one such study using PDAs in an educational context, Taiwanese primary school children were lent devices that allowed them to access and download online materials, browse the internet, take personal notes, and complete class exercises (Tan &

Liu 2004). Results obtained in post-testing and from a student-evaluation questionnaire conducted after the 12-week study showed significant learning gains and positive student evaluation of the implementation. The authors commented, "most students like to use the MOBILE to learn English as well as other courses since it is easy to use and can increase learning interest and effect" (Tan & Liu 2004, 534).

Thus, from early studies of the use of mobile technology in educational contexts it can be seen that even in their fledgling forms, mobile technologies were demonstrably engaging for learners, sparking learner interest, and showing early promise in terms of positive effects on learning outcomes.

Two further studies conducted in the same year looked at the effectiveness of personal digital assistants in the enhancing of reading abilities in Chilean L1 Spanish primary school pupils. The first of these studies (Zurita & Nussbaum 2004a), was conducted in-class and involved personal digital assistants with wireless functionality running an application designed to boost pre-reading word construction ability. In the second of these experiments (Zurita & Nussbaum 2004b) participants were split into two groups, the first worked with the application during sessions of 15 minutes in duration, while the second group acted as a control group and worked with printed teaching materials. In both studies learning outcomes were seen to increase significantly in post-testing but were higher for the experimental group. Post-testing of the second study revealed much greater improvements for the experimental group when compared with the control group (Zurita & Nussbaum 2004b).

Although these studies focused on L2 reading, interesting for the present research study is the early promise shown by studies comparing printed materials and digital presentation. Zurita and Nussbaum concluded;

> The introduction of mobile computer devices allows a learning environment where technology manages the necessary data and mediates to allow the students to work collaboratively following the constructivist principles, with less teacher support for its application than in CL [collaborative learning without computer support] activities. (Zurita & Nussbaum 2004b: 242)

These conclusions highlight the ability of MALL interventions to elicit a change in the learning environment, and thus to change the *ways* in which learners learn. Of interest here is not the mobile technology itself, but its effect on the pedagogical reality for the learner as they utilise technology in the learning process. As an additional comment, it appears that the implementation of technology provided additional support for language learners where previously, teacher-input may have been required (Zurita & Nussbaum 2004b: 242).

Observations such as these have implications in terms of arguments for the implementation of MALL in the language curriculum, as well-designed implementations could free up teacher time and energy which could be productively invested in providing language teaching of a higher quality in other areas.

Specifically, with regards EFL vocabulary learning, Chen and Chung (2008) trialled a mobile L2 English vocabulary learning system based on the concept of a learning memory cycle and a commonly applied theory in computerised testing known as Item Response Theory. Item Response Theory is described by the authors as;

> a widely used theory in education measurement, typically applied in the field of Computerized Adaptive Testing […] to select the most suitable items for examinees based on individual abilities. (Chen & Chung 2008: 628)

The implementation operated on personal digital assistants that were connected to a server, a client-mobile learning system, and three database agents. One of these database agents was programmed to recommend vocabulary to the learners based on items responded to, a second server was used to generate tests for the learners, and the third database agent was used to ascertain performance. Aimed at facilitating efficient learning, the bespoke system identified each individual learner's vocabulary ability and the optimal period of time between initial presentation of an item of vocabulary and its necessary review before forgetting, adaptively planning the periods between subsequent reviews for each learner. The study used pre- and post-test vocabulary learning performance tests to measure the effect of the system's use. After a trial of 5 weeks with 15 Taiwanese university students who were deemed to be of advanced level, statistically significant improvement in vocabulary abilities was reported, though admittedly only of moderate extent (~5%) (Chen & Chung 2008).

Although this study was unfortunately only conducted with a small number of participants (according to the authors, this was due to limited availability of hardware), a sample size that is certainly much too low to enable confident conclusions to be drawn, and was conducted over a short time-period, a factor that is of concern in many MALL studies (Burston 2014b: 349), interesting for the current research paper is the concept of a learning memory cycle and the possible role that time between exposure to vocabulary items plays in the laying down of long-term memories. Chen and Chung reported only moderate learning gains in this study, however the statistical significance of the results points towards the efficacy of MALL vocabulary learning applications that incorporate in their design, methods to optimise the review and repetition of vocabulary items to maximise the chances of subsequent LTM recall. Such

concerns will be taken up further in a discussion of the role of cognition and memory in vocabulary learning below (see section 3.5. below).

With the introduction of wireless internet connection capabilities, the myriad capacities offered by internet-connected, server-based systems such as database storage and instant querying of entries became a reality in the interests of language learning, thus giving birth to the next generation of e-learning implementations (Sharples 2000: 192). Personal digital assistant functionality was thus extended to offering early access to *radio frequency identification* technology which provides object-identification capabilities that allow mobile devices to provide the learner with context-specific language learning material.

The Japanese were the first to experiment with this technology in the teaching of mimetic and onomatopoeic words to L2 Japanese students (Liu 2009; Liu & Chu 2010; Liu, Tan & Chu 2007, 2010). Most relevant for the present discussion was a study by Wu et al. (2011) which focused on the efficacy of a specially developed personal digital assistant and smartphone-based system with radio frequency identification functionality that provided learners with context-specific vocabulary and location-appropriate texts in real-time to help with reading comprehension. A sample size of 113 Taiwanese university students were split into three groups for the study, a control group that learned from "paper-based materials" (Wu et al. 2011: 173), a first experimental group that received access to the bespoke situated learning system only, and a second experimental group that received access to the system with additional reading guidance mechanism which "dynamically calculated guidance parameters to improve the accuracy of the suggested reading materials" (Wu et al. 2011: 169). Over a period of 7 weeks, participants were required to read 20 articles related in some way to on-campus facilities, such as restaurants and shops. Once participants' personal digital assistants had identified the location of participants as being in one of eight classes of locations around the university campus, the situated learning system selected highly relevant reading material from the reading database for the participants to read at their location, thus providing readers with contextual cues from their physical locations whilst reading and interacting with the digital learning materials through the system's dynamic interface which allowed translations, audio pronunciation guides and recitation functions. Control group mean post-test reading scores were shown to increase in relation to pre-test scores by 1.6%, while a 25% and 30% improvement were observed in the two experimental groups respectively (Wu et al. 2011: 175). Interesting for this thesis are the author's conclusions that a situated learning system was able to raise the quality of learner performance (Wu et al. 2011). By utilising the mobility afforded

by the application, Wu et al. were able to harness a theory of learning known as *Situated Learning Theory* (see section 2.4.2 below), allowing learners to take cues from their direct environment during the reading process which was shown here to improve subsequent memory recall of specific pieces of information contained in the learning materials. This study also supports a cognitive theory of memory known as the *Depth of Processing Hypothesis* which will be discussed in due course below (see section 3.6. below).

Though not directly related to this research study, many more interesting pioneering studies were conducted on newly emerging technologies in the creation of tailored, user-specific and user-adaptable applications for language learning. The combination of *Global Positioning Systems* (GPS), radio frequency identification and online databases were used to create location-aware MALL applications for L2 English and Japanese learning (Ogata & Yano 2003, 2004a, 2004b; Ogata et al. 2004; Yin et al. 2004), while direct connection and communication between instructors and students in the support of collaborative task-based learning in authentic situations was also trialled in Japan (Ogata et al. 2008; Paredes et al. 2005). Further work on location-aware, ubiquitous mobile applications for language learning has also been carried out in Taiwan (Chen et al. 2009; Anderson, Hwang & Hsieh 2008; Liu 2009; Liu, Tan & Chu 2007, 2010). These studies invariably produced positive results and highlight the different ways in which mobile technologies can harness pedagogical paradigms such as situated learning theory in the delivery of learning materials to the language learner whenever and wherever they wish to engage.

2.2.3. Media player applications

With the arrival of the Apple iPod in 2001 came the widespread ability to easily transport and access multiple digital files (Cojocaru & Cojocaru 2014). No longer needing comparatively expensive and bulky personal digital assistants, individuals now had access to affordable and practical mobile technology. In 2004, as sales of the iPod overtook Sony Walkman sales to become the global market leader (Cojocaru & Cojocaru 2014: 116), the term "Podcast" was first used by Ben Hammersley as a blend of words derived from the word iPod (Sawyer 2015), and a trend towards the production of language learning podcasts began (Süleyman & Cabaroglu 2014).

Correspondingly, a number of MALL researchers began to experiment with the audio capabilities of portable audio to support and facilitate language learning (Cebeci & Tekdal,

2006; Dlott 2007; Zukowski 2007). Although there is relatively little existing research on the pedagogical implications of the use of audio-functionality within the context of MALL (Süleyman & Cabaroglu 2014) there have been some interesting studies conducted which support MALL use in the auditory learning of vocabulary and grammar.

As an interesting example, a study of L2 English learners in Iran by Baleghizadeh and Oladrostam (2010) for instance, used the sound-recording functionality of mobile phones to record discussions designed to provoke certain grammatical forms. A significant improvement in grammatical accuracy was observed in the experimental group on a post-test grammar quiz (Baleghizadeh & Oladrostam 2010). Unfortunately, however, results of this study have been called into question (Burston 2015: 8) as the pedagogical method used to teach the control group was only described as a "conventional way of grammar instruction" (Baleghizadeh & Oladrostam 2010: 83), highlighting the importance for future MALL studies of adequately reporting methodology, an issue that will be revisited below (see section 2.6. below).

2.2.4. Web-based applications

Wireless capabilities opened up a new world of possibilities for MALL (Sharples 2000). Early web-based applications focused on educating users in the fashion of tutorials that were centred on the learning of vocabulary and grammar (Stockwell 2007), listening comprehension (Nah 2011; Nah, White & Sussex 2008), and reading (Huang & Lin 2011). There have been a number of studies that have taken inspiration from collaborative, constructivist, task-based methodologies and have investigated mobile phone use in the maintenance of online blogs designed to aid in the L2 English integration of Chinese students in the United Kingdom (Shao & Crook 2015; Shao 2011; Shao, Crook & Koleva 2007). A similar application was assessed for the learning of Spanish by university study-abroad participants in Spain (Comas-Quinn, Mardomingo & Valentine 2009). Web-based audio-blogs have also been used in the submission of homework assignments and allowing the provision of instructor feedback in the US (Hsu, Wang & Comac 2008).

2.2.5. iPads and tablets

MALL studies dealing with the use of iPads and similar devices have been few and far between, however they do show some interesting results (Brown 2012; Brown et al. 2012; Munteanu et al. 2010; Munteanu et al. 2011; Yildiz 2012). Papadima-Sophocleous, Georgiadou and Mallouris for instance, reported on an experiment that investigated the effect of iPod Touch

use on the learning outcomes of L2 English oral reading skills. Participants downloaded texts with corresponding audio recordings in order to inform them as to the correct pronunciation. Students were able to significantly increase their reading speed and the accuracy of segmental and prosodic features (Papadima-Sophocleous, Georgiadou & Mallouris 2012).

2.2.6. Smartphone applications

As operating systems for mobile phones evolved throughout the 2000s, programmability improved in leaps and bounds and the use of new and more versatile computer languages such as Flash and Java enabled the development of a whole new creative world of MALL applications. This certainly changed the game in terms of the multimedia capabilities that a new generation of *smartphones* enabled, and this development gave birth directly to programmable vocabulary games which were duly researched (Fotouhi-Ghayvini et al. 2008; Fotouhi-Ghazvini, Earnshaw & Haji-Esmaeili 2009; Yang & Chen 2012), and multimedia programs designed to act as stand-alone tutorials for specific languages (Burston 2013).

Other points of interest in the world of seemingly endless possibilities offered by smartphone applications include tutorials of a multimedia nature, based on Adobe Flash. Anaraki reported on the design and implementation of a course consisting of bespoke Flash-based lessons for L2 English. This multimedia course was downloaded to the mobile devices of Thai university students, and pre- and post-tests were conducted to ascertain effects on learning outcomes. A significant improvement in scores on post-test assessments was recorded, alongside an overall reduction in time spent on each task (Anaraki 2009).

With all this said, and in consideration of the technological development that has occurred in the area of mobile technology in terms of the recent rise of the smartphone, it must be noted that, "pedagogically, nothing new has been done with smartphones that has not already been done with earlier mobile devices" (Burston 2014a: 108). Mobile applications, or *Apps* as they are colloquially termed, after achieving popularity in the latter half of the 2000s, have naturally been created for both the Apple and Android operating systems and number in the 100s for L2 English learning (Burston 2014a: 108). However, attention has been rightly drawn to the fact that, once one considers the actual substance of what the learner is required to do, or how the learning material is presented from a pedagogical perspective, current applications do not extend much further than traditional language learning methods such as multiple choice and gap-fill exercises, flashcards and drills (Burston 2014a). Underscoring this observation, a

systematic evaluation of mobile applications was conducted by Kim and Kwon (2012) and concluded that the pedagogy utilised was mostly form-focused, and test-based.

In conclusion it can be seen that far from revolutionising the teaching process of languages, MALL has, so far, only succeeded in reproducing the traditional methods of the language classroom, and in addition, has replicated the techniques and methods that were tried and tested in the early days of CALL which were subsequently copied in early studies using personal digital assistants, MP3 players and early mobile phones (Burston 2014a: 108; Kukulska-Hulme & Shield 2008: 283).

2.3. Mobile-assisted vocabulary learning

Focusing now on the application of MALL specifically to the learning of L2 vocabulary, it can be seen from the literature that the use of mobile phones and smartphone applications has become a particularly popular method of learning English vocabulary (Lin & Lin 2019; Burston 2014b; Zhang, Song & Burston 2011; Kukulska-Hulme 2009). Correspondingly, over the last 20 years the area has seen a consistent rise in the number of MALL studies focusing on vocabulary acquisition (Lin & Lin 2019: 3) which has been shown to be the most frequently targeted language skill in the research area (Burston 2015: 8). Studies have focused on many different elements of the vocabulary acquisition process, for instance, investigating the delivery and presentation modes of vocabulary items (Anaraki 2009), ascertaining the effects of various different m-Learning applications on learning outcomes (Sandberg, Maris & Hoogendoorn 2014), and, as already discussed above, investigating the effects of context-aware mobile technology (Chen & Chung 2008). In the overarching majority of cases, studies have reported positive results both in terms of increased word retention, increased learner motivation, and positive learner attitudes (Lin & Lin 2019: 1; Burston 2015: 16).

Generally speaking, the main focus of research carried out to-date has been to establish whether or not MALL interventions can outperform traditional, paper-based methods of learning vocabulary, and have therefore mainly employed comparative research designs to show statistical differences between experimental group and control group with regards learning outcomes and learner perceptions (Lin & Lin 2019: 3). A small number of examples of such studies have been selected here for brief analysis in support of the present discussion.

An example of such a study is an investigation by Wu (2015), which reported on a bespoke vocabulary learning mobile application which was tested on 70 Chinese university students. A

pushing method was utilised to send participants in the control group and the experimental group SMS text messages containing vocabulary learning materials. Results showed a statistically significant 6.96% improvement in the experimental group. Reasons given for the significant results were the ease of accessibility and convenience of the application for participants who were all "accustomed to electronic devices" (Wu 2015: 177). Also cited by the author was the superiority of the application's functionality over and above the paper-based vocabulary lists received by the control group, sporting as it did a function that allowed the experimental group to quickly and easily focus on words which they found especially difficult, and most importantly for the author, the increased motivation experienced by the experimental group over a long learning phase. The study took place over a period of 55 days and it was suggested that the control group struggled with motivation over the time period in comparison to the experimental group, who "probably" spent more time engaged with the learning materials and studying during periods of "dead time" (Wu 2015: 177). The factor of improved motivation and learner interest has also been noted time and again by many other researchers (Lin & Lin 2019: 4). In relation to this discussion, it appears from this study that there are two issues of note. The issue of learner autonomy, namely having control over what and when to revisit and self-test can be argued to have increased the efficiency of the learning process here, as participants in the study were able to quickly and efficiently test themselves on items that they themselves knew needed additional revision. Secondly, the issue of quick and easy accessibility to differing modes of presentation of vocabulary items seems to have contributed in no small part to the significant results obtained.

Further studies that have investigated the effects of SMS and MMS messaging on vocabulary retention have similarly produced positive results. A report on the effects of MMS messaging on L2 English vocabulary learning was carried out by Lin and Yu (2012). Junior high school students in Taiwan were asked to learn 9 new vocabulary items per week which were delivered using four different methods: one group received vocabulary via text, which included the syntactic category along with a Chinese translation; text plus an image related to the vocabulary item; text plus a sample of audio pertaining to pronunciation of the vocabulary item; and finally, text plus both an image and an audio sample. Learning outcomes were positive for all four conditions (presentation modes) of the experiment and no significant differences were found between the four modes (Lin & Yu 2012). Within the context of this study, investigations such as these highlight the possible need for a multi-modal approach to the presentation of vocabulary items to increase the likelihood of subsequent recall. This observation is again

supported by theories of learning such as the *cognitive theory of multimedia learning* (Mayer 2001) (see section 2.4.3. below), and the *Depth of Processing Hypothesis* (see section 3.6. below). There are many more examples of such studies that generally support the conclusion that SMS and MMS modes of vocabulary presentation result in significantly better learning outcomes when compared with other, paper-based methods (Alemi, Sarab & Lari 2012; Levy & Kennedy 2005; Tabatabaei & Goojani 2012; Motallebyadeh, Beh-Afarin & Daliry 2011; Zhang, Song & Burston 2011).

Effects of different modes of multimedia presentation were also investigated by Lin and Yu in a later study, for which the researchers designed an experiment to replicate previous results obtained in studies that looked at the integration of mobile technology with the cognition of language learners. Learners were presented with vocabulary in a variety of different ways, digital text in isolation, digital text and a picture, digital text and sound, and finally a mixture of all modes. Results of immediate vocabulary tests and a cognitive load questionnaire revealed that the audio-mode of presentation reduced the cognitive load on participants which in turn, increased vocabulary retention (Lin & Yu 2017: 540).

Similar studies support these conclusions. Agca and Özdemir (2013) for instance, presented multimedia content related to 84 items of randomly selected vocabulary from an English course book and linked the vocabulary to a mobile application via Microsoft Tag technology which allowed participants to scan the tag in their coursebooks and access related multimedia materials. Forty university students took part in the study which only lasted for a period of one week. The study showed that presenting vocabulary along with different forms of media to an experimental group (n=20), significantly affected participants' learning outcomes in comparison to the control group (Agca and Özdemir 2013: 784). Agca and Özdemir also collected qualitative data on participant perceptions and reported that respondents generally found the use of their mobile phones as "innovative" with the authors reporting that "the learning environment created curiosity for students and made the vocabulary learning activity more attractive" (Agca and Özdemir 2013: 784).

Additionally, Wu (2014) investigated the effects of smartphones on the vocabulary learning of 50 college students by presenting Vocabulary items in conjunction with pronunciation, antonym, synonym, part of speech and an example of use in a sentence or phrase. Participants were split equally into experimental and control group and presented with 852 vocabulary items that had been taken from their regular textbooks and asked to revise the items daily over a

period of one semester. While the control group were instructed only to use their textbooks to learn the full set of vocabulary, the experimental group were given access to a mobile application designed and coded by the author named Word Learning, that utilised a searchable database containing the 852 items of vocabulary along with their related modes of presentation, and a user interface that allowed different searches to be performed and different modes of presentation to be initiated on command. A sample test command was also included, allowing participants to select the items of vocabulary they wished to be tested on and test their knowledge. Results showed that the experimental group significantly outperformed the control group on post-test of 100 randomly selected items. The author specified four reasons as to why they believed the experimental group had significantly outperformed the control group. Firstly, the multimodal presentation of the learning material was highlighted and the ability of the experimental group to learn vocabulary items in conjunction with the seven features offered by the application essentially cemented the items in LTM with a far greater rate of success than the control group. Secondly, it was noted that the application allowed the participants to "see" all presentation modes and learning features at once, thus rendering the use of smartphones more suitable for today's learners' who the author refers to as "better visual learners who have grown up on using video games, computers and mobile phones to obtain new information" (Wu 2014: 305). Thirdly, the author highlighted two features of the application, namely the unknown words function which allowed participants to identify which items of vocabulary they needed to work on, and the sample test function which allowed participants to frequently test themselves on words that they knew needed more revision. Finally, as with the author's later study discussed above, it was speculated that the significant learning outcomes in the experimental group might be partly attributable to the length of the study, with the experimental group apparently giving the impression of increased autonomy as the study went on (Wu 2014: 305).

Some MALL vocabulary studies have specifically looked at flashcard presentation. Nikoopour and Kazemi (2014) investigated the difference between the use of digital and non-digital flashcards. 109 university students were presented each week with 70 flashcards with commonly occurring TOEFL and IELTS vocabulary over a period of ten weeks. Participants were allocated to three separate groups that differed in the subsequent method of flashcard delivery, namely *paper*, *online*, and *mobile*, where the paper group accessed only paper flashcards, the online group accessed the flashcards via an online website, and the mobile group were given access to a mobile application which allowed them to access the flashcards on their

mobile phones. Groups were then presented with identical flashcards consisting of a vocabulary item on one side and the item's definition, example/s, synonym/s, and/or antonym on the other. In a comparison of pre- and post-test vocabulary learning outcomes measured via a specially designed and piloted vocabulary test, results showed no significant difference between participants' learning outcomes when utilising digital modes of presentation, namely online and mobile presentation methods, in comparison to the paper presentation method. However, a significant difference was found between the digital methods themselves, with participants in the mobile group significantly outperforming the online group, and, most interestingly, results were significant when comparing portable methods of presentation (paper and mobile) with the online group. As flashcard contents for all three groups were identical, the author's concluded that "[t]he outperformance of the vocabulary learning of Mobile Group over the Online Group seemed to be due to the portability and high accessibility of cell phones" while insignificant results between paper and digital methods of presentation were attributed to the Online group's "limited Internet access and consequently limited time of study […] which dragged the high mean of the Mobile Group down" (Nikoopour & Kazemi 2014: 1371-1372). Concerning the significant difference found between portable and stationary methods of delivery the authors concluded "[w]hile the Online Group members were not able to take their flashcard package with them everywhere all the time, the Mobile Group and Paper Group members did benefit from the ubiquity and portability of the delivery devices" (Nikoopour & Kazemi 2014: 1372).

Here it can be seen that the potential of ubiquitous access to materials *anytime* and anywhere that the learner wishes to learn can produce significant learning outcomes when compared to methods of materials access or presentation that do not allow this paradigm to exhibit its influence. This observation lends support for the conclusion that it is the *anytime, anywhere* ubiquitous access of materials that MALL applications allow that offers a compelling argument for their use, however, as can also be seen, when learning materials are identical this is not a claim that is exclusive to MALL applications as paper-based materials are comparably portable and accessible and learners therefore can be shown to benefit just as much from their usage.

In another study Shimoyama and Kimura (2009) tested the efficacy of a mobile-based flashcard program combined with audio for the teaching of L2 English vocabulary. An experimental group was compared with a control group on the addition of supplementary graphical representations of example sentences, with both groups receiving access to the mobile-based flashcard/audio program that presented English/Japanese word pairs in both text and audio

form. Scores for both groups showed significant improvement in post-testing, although no significant difference was found between the groups (Shimoyama & Kimura 2009).

Turning now specifically to the investigation of readily available smartphone applications, Jafari and Chalak (2016) conducted a study looking at the effects of using WhatsApp on the vocabulary learning of Iranian university students. Four vocabulary teaching sessions per week were provided to an experimental group which was compared with a control group who learned through traditional text-book teaching. The study found that although the experimental group rated their experience of using the app as positive, equal improvement was observed in both groups, and differences in post-test vocabulary scores were statistically insignificant.

A study conducted in Iran by Azabdaftari and Mozaheb (2012) focused on the effects of a mobile flashcard application called *Space Repetition System* on English vocabulary learning. An experimental group were given access to Space Repetition System on their personal mobile phones while the control group used only paper flashcards. Results showed that the experimental group outperformed the control group who used only paper flashcards (Azabdaftari & Mozaheb 2012). Mobile phone-based flashcard applications were also the focus of a study by Basolğu and Akdemir (2010), who tested an application known as ECTACO. An experimental group utilised the application while a control group learned with traditional printed flashcards. Findings suggested that the use of ECTACO was significantly more effective at improving learner's vocabulary than their physical counterparts (Basoğlu & Akdemir 2010). The significance of these results has however been called into question (Burston 2015) and this issue will be addressed further below (see section 2.6. below). Other studies investigating the effects of mobile application use on vocabulary retention have generally reported positive and statistically significant results (Choi & Jeong 2010; Chun 2011; Lin & Lin 2019).

This discussion will now turn to theories of learning that have been shown in the literature to underpin the learning of languages through the utilisation of mobile technologies in an attempt to shed light on the potential of MALL implementations to add to or indeed perhaps even change language pedagogy in ways that could be of advantage to EFL language learners.

2.4. Theories of learning in MALL

It has been suggested, that with the introduction of technology into language learning contexts, a paradigm-shift in education becomes possible simply as a result of the opportunities that technology opens up for the re-definition of the nature of learning itself (Barrs 2011: 228). Such bold and grandiose statements are not uncommon in the literature (Sharples 2000; Attewell 2004; Hardless, Lundin & Nulden 2001; Roschelle 2003), however, the reality has been shown to be quite different, as far from changing language pedagogy, it has been shown that MALL implementations to date have tended to be based upon out-dated pedagogy which has hindered the area's progress (Burston 2014b: 352).

There are of course many ways in which *learning* can be viewed, and this is just as true with regards to learning with the help of mobile technology. It must be noted here that it is still the case that no single learning theory dominates outright and there are many different ways in which learning can be conceptualised. Nevertheless, of the multiple learning theories that have been shown to be either marginally or directly related to both MALL and its older cousin CALL, three theories in particular have been shown in the literature to be more significant than the rest. In how far these theories have been adequately leveraged and exploited by MALL implementations to-date remains a matter of heated debate.

Many theories of learning have been proposed as having either a marginal or a direct relation to m-Learning. In a detailed overview of modern perspectives, theories and practices, Keskin and Metcalf comprehensively listed these theories in an extensive summary (2011: 203-205), however, three main theories have been shown in the literature to have a wider connection with and influence on m-Learning, namely; *socio-cultural learning theory* (Vygotsky 1978), *situated learning theory* (Lave 1988), and the *cognitive theory of multimedia learning* (Mayer 2001).

2.4.1. Socio-cultural learning theory

In *socio-cultural learning theory*, originally proposed by Vygotsky (1978), learning is regarded as a social process in which learners expand their knowledge through interaction with others more proficient than themselves. Application of socio-cultural learning theory in the context of second language learning was initially advanced by Frawley and Lantolf (1985) in their application of the theories of Vygotsky in the second language classroom. These two pioneering language teachers concluded that the *second language learner* (SLL), far from copying the words or actions of the more proficient instructor/s or peer/s, instead continuously

interprets and assimilates new inputs that they receive and endeavours to utilise this new information as a tool with which to attain the same level as their social partners (Shabani 2016: 2). This development is all conducted within a social context and therefore, it is held that such development cannot be considered outside of that context due to the negotiation of meaning between the learner and the more-proficient speaker (Shabani 2016: 2).

When considering Vygotsky's original writings, a significant aspect that he proposed within the context of the theory was his notion of a *Zone of Proximal Development* (Vygotsky 1978). This proposal posited the existence of an optimal zone in which the actual developmental level of the learner, and the potential developmental level are wide enough apart to allow the optimal advancement of the learner (Turuk 2008; Frawley & Lantolf 1985). Advancement from the true level to the potential level of the learner is made possible by what Vygotsky termed *scaffolding* and *mediation* between the two levels (Vygotsky 1978).

The term *scaffolding*, within the context of socio-cultural learning theory, refers to a specific social learning situation which can be created by the more proficient learner or teacher, that allows the learner to experience learning as a step-by-step process in which provision for their current level is always made and offered as a stepping stone that they can use to progress to a more advanced level (Donato 1994). In other words, answers are not simply given, instead, meaning is negotiated in a way that provides the learner with the material needed to progress in their capabilities. Scaffolding situations are thus created through mediation of the setting, language, and other tools that enable the learner to notice the gaps in their own language and utilise the available tools on hand to progress (Jang & Jimenez 2011).

2.4.2. Situated learning theory

Situated learning theory was proposed by Brown, Collins and Duguid (1989). McLellan (1996) also took the view that learning cannot be considered without reference to the context in which it takes place. Thus, it has been noted that knowledge itself "exists not as a separate entity in the mind of an individual, but […] is generated as an individual interacts with his or her environment" (Orgill 2007: 187). At its point of departure, situated learning theory makes a number of major assumptions about how, why, and most importantly in which contexts learning takes place. Proponents of the theory support the notion that knowledge is acquired primarily in an *authentic* context with reference to the way, or ways in which knowledge might be utilised in the future. A further fundamental assertion is that a learner's understanding of a particular concept is continually under construction, continually finding fertile ground within

the context of social interactions, with learning often being the natural result of interaction or dialogue with others (cf. section 2.4.1. above) (Orgill 2007).

situated learning theory is an attempt to depart from dominant, dualistic, theories of learning and is an important step towards a reformulation of educational activities as being primarily social and cultural phenomena. The theory stands in opposition to alternative conceptions that regard the mind and mental processes as central to learning processes, as is the case with theories that can be classed as being structuralist or educational perspectives (Arnseth 2008). Perspectives on learning are essentially reduceable to fundamental views on human behaviour, with structuralist perspectives holding that behaviour is a result of underlying, pre-existing structures in the brain that guide and produce action. Situated learning theory on the other hand, as a social-constructionist perspective, considers behaviour to be a result of the learners' environment and to be describable only within the context of that environment (Brown, Collins & Duguid 1989).

As stated above, situated learning theory regards learning to be the result of a confluence between what is to be learned and the learner's contextual surroundings. Thus, the more realistic or authentic a learning situation is, the stronger the effect of this agreement between context and the information to be learned, and thus the higher the likelihood that learning results in strong and lasting effects (Lave 1988). In terms of m-Learning, the utilisation of mobile devices can be seen to support the learning process through situated learning, as students are able to engage in learning processes wherever they happen to be, and thus in *authentic* contexts (Cheon et al. 2012). MALL researchers have highlighted the learner-centred aspects of m-Learning in the context of SLA and EFL (Kukulska-Hulme 2009) and highlighted the fact that mobile technologies open up aspects of language learners' experiences that are not usually accessible (Abdallah & Mansour 2015). In conclusion, it can be seen that the implementation of mobile technology can situate learning in a context that is meaningful, as it provides learners with opportunities to socially interact and to share their experiences (Brown 2000).

2.4.3. Cognitive theory of multimedia learning

The *cognitive theory of multimedia learning* is based upon the simple premise that, during the act of learning, there are two main channels through which information passes and is processed in the learner's brain, namely, the visual channel and the auditory channel (Mayer 2001). In Mayer's view, during instruction the learner's brain is processing new information that is presented to consciousness through the visual system and the auditory system simultaneously

and is integrating that information with prior knowledge which ultimately enables understanding to take place (Mayer 2001).

It is thus the teacher's aim, or indeed the express goal of any method of instruction under this theory, to make as much use as possible of both these channels when presenting new information to the learner (Mayer 2001). The use of mobile technology, therefore, enables both channels to be more efficiently utilised in the presentation of learning materials, and this within the *anytime, anywhere* paradigm unique to m-Learning (Li 2013; Rouhi & Mohebbi 2013).

2.4.4. Comparing and contrasting theories of learning in MALL

Within the context of MALL and the question of curricular integration, the learning theories discussed above do not necessarily need to be treated as mutually exclusive but can be utilised simultaneously in support of the learning process. Though separate theories, each with differences regarding the weight placed on different factors in the learning process, they often complement each other and can be used in tandem to support the effective learning of language. The perfect MALL implementation would optimally leverage single or desired combinations of theory elements dependent upon what the task, or learning material demanded.

Mobile technology is of course not a requirement for situated learning to occur, however, it naturally comes into its own when enabling the learner to be mobile and therefore to place themselves in the perfect situation for particular elements of learning processes to optimally take place. Additionally, mobile technology is not the only medium through which the power of the cognitive theory of multimedia learning can be leveraged, and the same applies to taking advantage of socio-cultural learning theory and the enabling of social interaction with more competent peers. However, mobile technology undoubtedly offers wider access and opportunities in diverse contexts that would previously not have been open to the learner.

The three learning theories mentioned above, as the literature shows, do not necessitate new technology in the realisation of their effects on the learning process, however, when combined through mobile technology specifically designed to effectively leverage all the major factors involved by coupling them with the unique aspects of mobility provided by such technology, the resulting effects have been shown to be significantly positive in the majority of studies highlighted.

2.5. The question of curricular integration

It was widely predicted during the 2000s that the use of mobile technology would revolutionise education, and with it the teaching of foreign languages, and many highlighted the endless potential offered by MALL in the learning of language (Sharples 2000; Attewell 2004; Hardless, Lundin & Nulden 2001; Roschelle 2003). Others predicted a revolution based on the blanket implementation of wireless technology, and went as far as stating that the transformation in the traditional classroom to a fully digital environment was already well underway and the future of all education would indeed be transformed by the *anytime* and *anywhere* paradigm (Cavus & Ibrahim 2009: 78). Still others went further and stated that MALL was already "becoming commonplace" (Abdous, Camarena & Facer 2009: 76).

All these claims, though they made good reading for long-term supporters of the use of mobile technology in language education, have yet to truly come to fruition. Although successes have been widely reported, a closer, critical look at studies reveals inconsistencies and general concerns about a range of factors such as study design, lack of adequate reporting, and lack of objective measurement of learning outcomes, factors which it could perhaps be presumed would have been more thoroughly taken into account in more established areas of language research (Burston 2014a, 2014b, 2015). In order for mobile technologies to fulfil their potential in mainstream education, it is clear that a number of factors need to come into play, not least it seems, a recognition of the particularly mixed picture presented to-date by much of the published literature in the area (Burston 2014a, 2015).

From the literature review above, it can be seen that relatively few reported implementations, despite mainly positive research findings, have in reality been adopted as part of any recognised curricula (Hao et al. 2019). It can also be seen that far from revolutionising traditional education; MALL implementations have generally only succeeded in reproducing methods and techniques that have long been in use in traditional language learning (Kukulska-Hulme & Shield 2008: 283; Buston 2014a: 108). This raises legitimate questions concerning the true locus of any advantages promised by such technology, and suggests that perhaps the potential of mobile technology will be realised as a result of its mobility after all, and not, as many have hoped, as a result of revolutionary new pedagogy.

In terms of the underlying pedagogy and methodological approach behind MALL implementations in curriculum-based language programs, many researchers are of the opinion that a perhaps less obvious but much more pervasive reason as to why adoption of mobile technologies in mainstream pedagogy has been hampered is the fact that methods used have in

general contradicted dominant constructivist and learner-centred assumptions which underpin modern foreign language teaching methodology (Burston 2014a: 115-116). A closer look at the perspectives behind many studies reveals an undercurrent of structuralist assumptions, with the focus being placed on drills and other rote-learning methods such as flashcards. Observations have been made by such authors as Kukulska-Hulme (2009) and Godwin-Jones (2011), who have brought attention to the lack of creativity and mostly teacher-centred designs that have been generally evident in MALL applications. Constructivist approaches however, such as student-centred, collaborative, or communicative methodologies have generally been ignored in the area (Godwin-Jones 2011: 7). As Godwin-Jones notes, "[t]he problem is less one of hardware/software shortcomings and more in developers' conceptualisation of how language learning could be enhanced in new, innovative ways with the assistance of mobile devices" (Godwin-Jones 2011: 7).

There is, however, much that is positive that can be taken from the literature that supports the notion of curricular integration. It cannot be ignored for instance that technology improves learner's motivation to learn, their engagement with teaching materials, and subsequent productivity (Roblyer & Doering 2010). As mobile technology, which has been described as "the swiss army knife of technology" (Thomas, O'Bannon & Bolton 2013: 296), continues to develop and increase in functionality, it can be expected that language learners will utilise this functionality regardless of whether teachers or educational bodies choose to integrate this functionality into their teaching or not. Indeed, it has been noted by Johnson, Adams and Cummins that "the power of apps, coupled with the portability of mobile devices, is causing many schools to take another look at their policies" (Johnson, Adams & Cummins 2012: 11).

For the future it could be stated that for MALL to make a measurable impact on foreign language instruction within the context of secondary education, such as is the focus of the current study, a quantifiable enhancement in learning outcomes or demonstrable advantage to the efficiency and long-term stability of learning outcomes needs to be definitively shown and supported in follow-up studies in order to support the use of MALL in the language classroom or as part of recognised language curricula. This must be coupled with an adherence to supported pedagogical practices and these will need in turn to underpin any proposed interventions. Additionally, the promises of fast and efficient delivery of educational resources into the hands of learners *anytime* and *anywhere* must be exploited within the context of a pedagogically founded language learning curriculum that is integrated seamlessly into current

EFL teaching models and courses to ensure that the implementation of these new technologies enhances and complements rather than distracts and complicates.

Taking a positive view of what the future holds for the implementation of mobile assisted language learning in the modern-day classroom, the technology necessary for its seamless implementation in the teaching of foreign languages in the language learning classroom is certainly already in place and ready to be utilised by well-researched and fully grounded proposals for implementation from the research community. There is no doubt that ubiquitous learning environments that may be accessed through both mobile and stand-alone technologies such as laptops within and outside the classroom as part of a standard language learning curriculum is now possible. As highlighted by many authors such as Burston (2014a), for MALL to reach the full potential that has always been the promise, it is no longer a question of technology but is now simply a question of pedagogy. Furthermore, it can be expected that as technology progresses in terms of processing power and functionality, we can safely predict the continued trend towards increasing mobile device capabilities which in turn will open up further opportunities for their creative use in the field of education both inside and outside the classroom.

Finally, it is important to note that although MALL has tended to focus on the use of mobile technology solutions outside the language learning classroom, these technologies, due to their seamless integration with online technologies, can be utilised in combination with web-based programs and thus offer up an entirely new educational concept, namely the integration of a fully online classroom, accessible wherever learners happen to be and whenever they wish to learn. This, and many other expectations for the future, still require research and development, however, the technology exists, and only requires curricular integration. Whether or not this represents an advantage to learners and teachers alike, and whether it is a future that is desirable is left up to researchers and experimenters in the area to show. MALL, as an increasingly relevant area of language research, currently stands at a pivotal point in terms of the area's development, and it remains to be definitively shown if the space can fulfil its many promises.

2.6. Research concerns

Despite the mostly positive results of much of the MALL research outlined above and the mostly positive picture that has thus far emerged, concerns have quite rightly been raised about the nature of existing studies. There is unfortunately, much to criticise methodologically and in terms of existing rationale behind existing studies and their often questionable and sometimes ideological conclusions (Burston 2014a). With relation to this study it will be worth briefly addressing some these criticisms.

Attention has been drawn to the severe lack of follow-up studies or reports on published MALL implementation studies (Burston 2014a). According to a review of the published literature between 2009 and 2012, the overwhelming majority of studies were stand-alone studies, and only around 12 teams of researchers published more than two papers in that time-period. Exceptions include rare studies that have been conducted with large numbers of participants over longer time-periods and have as a direct result warranted follow-up studies in the literature (Abdous, Facer & Yen 2012). It seems that it must be concluded that researchers and experimenters currently active in the area are still what one could term *early adopters*, and as Burston rightly notes, MALL is "yet to influence the core of the language teaching profession" (Burston 2014a: 103).

Although studies can be said to conform to the exacting standards of linguistics publications, it has not gone unnoticed that many studies and papers omit vital information. Decisive details that would allow measured conclusions are sadly lacking in many papers (Burston 2014a). It has been noted that of 291 MALL studies reviewed, only a very small number, 35 in total, met minimal standards of duration and sample size (lasting for at least a month, and involving more than 10 participants) (Burston 2015). Additionally, it was found that of 345 papers published between 1994 and 2012, only 289 reported the educational context in which the study took place, and only 288 stipulated the exact mobile technology used (Burston 2014a: 109). For obvious reasons, this situation poses problems for researchers wishing to compare studies and conduct statistical analysis of MALL research findings in general.

However, by far the most pressing concern is a clear lack of objectively quantifiable measures of learning outcomes. Studies have tended to focus on subjective assessments by teachers and learners, formulating conclusions on interventions and making claims of positive learning outcomes on the basis of these measures. According to a recent review of 291 MALL studies, 219 of the 291 studies reviewed were reported as containing quantitative data, with many instead concentrating analysis on self-report questionnaires and interviews (Burston 2015).

A further criticism often levelled at MALL vocabulary learning studies and one that certainly needs to be addressed in the current study is the issue of L2 proficiency level. For obvious reasons, it is essential to ascertain participants' proficiency before undertaking the study of any vocabulary learning intervention (Burston 2015). Many studies have been criticised for not reporting on participants' language proficiency, thus leaving positive results attained open to being simply measures of existing vocabulary knowledge. One such example is a study conducted by Cavus and Ibrahim (2009) which reported particularly large positive effects of an SMS vocabulary learning intervention. Due to lack of learner proficiency measures, there is unfortunately no way of telling the extent of the positive effects that were attributable to the implementation and how much of a role participants' existing language proficiency played (Lin & Lin 2019: 21).

Another concern of note, although one which sadly cannot be addressed here is the issue of short-termism. Most MALL studies, around 67%, have focused on extra-curricular learning and have not been linked to any kind of long-term program of study (Burston 2014b: 345). This raises questions concerning their orientation towards the overall long-term effectiveness of the chosen interventions and in turn makes arguments for their implementation in long-term language learning programs problematic. Further testament to this short-termism are the comparatively short timeframes over which most studies have been conducted. It has been noted that only 30% of studies from 2009 to 2012 were conducted over a time-period of only "a week or less", with "more than three quarters of these lasting less than three hours and some no more than five to ten minutes" (Burston 2014a: 112).

Turning finally to concerns raised about MALL in general, the *anytime and anywhere* paradigm made possible by mobile technologies that is often touted as being an educational game-changer, has, quite rightly, been criticised as being wholly unsuited to the learning process. It is certainly a valid argument, that being able to dip-into and dip-out of learning materials anytime and anywhere seems to be a positive factor for learners, however, the practicalities involved present some very real problems. In order to effectively learn, for example, a degree of concentrated attention is needed which in turn suggests that there are indeed some physical localities that are wholly unsuitable. Learners have thus expressed concerns over the difficulties they've experienced simply concentrating whilst travelling for instance (Lu 2008: 522; Reinders & Hubbard 2013: 11). Further concerns have been raised concerning learner perceptions of mobile devices which are predominantly used for communication and entertainment purposes. Studies have raised concerns about existing learner perceptions of

mobile devices, suggesting that learners may regard their mobile phones as devices for the carrying out of personal and social activities and not as tools for learning (Stockwell 2008: 255).

2.7. Summary

There are a number of important insights that may be garnered from the above literature review. From early studies of the use of mobile technology in educational contexts it can be seen that even in their fledgling forms, mobile technologies were demonstrably engaging for learners, sparking learner interest, and showing early promise in terms of positive effects on learning outcomes. Mobile technologies are demonstrably engaging for language learners and have continually been shown to be motivating and to be perceived as being helpful in the language learning process (Tan & Liu 2004; Lin & Lin 2019: 1; Burston 2015: 16; Agca and Özdemir 2013; Wu 2014). It may also be suggested that the data-handling capabilities of mobile applications have been shown to ease the workload on teachers, freeing up time that can be profitably used elsewhere to provide a higher standard of instruction (Zurita & Nussbaum 2004a; 2004b).

The concept of a learning memory cycle for individual vocabulary items has produced significant learning gains, showing the ability to MALL applications to leverage features of human memory in the forming of strong impressions in LTM. Spaced repetition of vocabulary items at optimal intervals, therefore, is potentially a highly significant factor in vocabulary learning that is efficiently exploited through the use of mobile applications (Chen & Chung 2008; Azabdaftari & Mozaheb 2012).

MALL implementations have been shown to allow the leveraging of differing pedagogical paradigms such as situated learning theory. Studies have shown that different pedagogical paradigms can be harnessed to produce significant learning gains by delivering context-related and context-dependent material to learners wherever they happen to be and harnessing the social power of collaborative task-based learning in authentic situations (Zurita & Nussbaum 2004a; 2004b; Wu et al. 2011; Ogata et al. 2008; Paredes et al. 2005).

Furthermore, the amount of cognitive effort and the depth to which an item is processed has continually been shown by studies to produce significant improvements in learning outcomes. Multimedia presentation methods such as additional audio, image, and video materials that are easily enabled and exploited by mobile technology have been shown to successfully achieve

this deeper processing in learners and thus can be seen to have significant advantages over paper-based materials precisely due to the advanced functionality offered (Baleghizadeh & Oladrostam 2010). It appears therefore that a multimedia, multi-modal approach to the presentation of vocabulary items is preferable and leads to better long-term outcomes in terms of recall on subsequent vocabulary tests (Baleghizadeh & Oladrostam 2010; Lin & Yu 2012, 2017; Agca and Özdemir 2013; Wu 2014; Shimoyama & Kimura 2009).

Ease of accessibility of learning materials has been shown to be a significant factor in producing positive learning outcomes in comparison to paper-based methods of learning (Wu 2015). Additionally, the issue of learner autonomy has also been shown to increase motivation and also the efficiency of learning (Wu 2015). Added to this, the ubiquitous access to materials *anytime* and *anywhere* that is enabled by MALL has been shown to produce significant learning outcomes by comparing identical learning materials and altering only the method of presentation (Nikoopour & Kazemi 2014).

On the less positive side, it can be seen that far from revolutionising language pedagogy, mobile application design to-date has only succeeded in reproducing mostly out-dated forms of pedagogy that are distinctly, behaviourist, form-focused exercises and drills (Burston 2014a: 108; Kukulska-Hulme & Shield 2008: 283). In addition, concerns expressed in the literature centre around a perceived failure pedagogically to leverage the clear opportunities presented by the connective capabilities of mobile technology and thus to put into practice dominant methodological assumptions in language pedagogy. According to some, these failures have, in many ways hindered the acceptance and adoption of mobile devices into mainstream curricular-based communicative language teaching programs.

Nevertheless, the fact cannot have escaped the reader that these perceived failings should be remarkably simple to overcome and will only take the creative design of new and innovative communicative applications that can run seamlessly on readily available operating systems. The widespread integration of mobile technology into existing communicatively based curricula should therefore be viewed only as a question of developers' and researchers' vision and ambition rather than any cost-based or technical concerns, and MALL's lack of influence so far is perhaps more reflective of ideological differences between developers writing mobile applications, and trained pedagogues.

In summary, the MALL research area is still a marginal area of language research and has yet to truly make an impact on the world of mainstream foreign language instruction. Although

there has been a widely reported upswing in research interest, undoubtedly connected with recent developments in mobile technology, a distinctly technocratic focus still remains discernible in the area, which, with definitive links to long-outdated pedagogical approaches, have prevented MALL's acceptance into the communicative language pedagogy mainstream. The leveraging of the potential that mobile technologies have long promised in terms of increasing successful learning outcomes in both in-class and out-of-class contexts, however, is still awaiting adequate research. Therefore, it must be definitively stated that the potential of MALL cannot be considered to have been adequately realised or reported in the literature, and therefore, the revolutionary potential of the technology may well still be to come.

3. Vocabulary learning

> There is not much value in being able to produce grammatical sentences if one has not got the vocabulary to convey what one wishes to say […] Without grammar very little can be conveyed, without vocabulary, nothing can be conveyed. (Wilkins 1972: 111)

Both language comprehension and language production are impossible without adequate vocabulary knowledge. Leading researchers now agree that the acquisition of vocabulary is an essential element of language learning, indispensable in the acquisition of language knowledge and skills (Nation 1990, 2013; Cameron 2001, 2002; Schmitt 2000, 2010), and can be predictive of an individual's ability to learn a language (Meara & Jones 1987, 1988). It has even been suggested that, "language ability is to quite a large extent a function of vocabulary size" (Alderson 2005: 88). Additionally, it has been noted that of the many skills necessary to master a language, reading ability and accompanying vocabulary knowledge are the two most important interdependent components (Huckin, Haynes & Coady 1993). Further underscoring the pivotal role that vocabulary knowledge plays within the language system, it has been convincingly argued that vocabulary knowledge is the fundamental driving force behind grammar development (Bates & Goodman 1997), elevating vocabulary knowledge to the status of an essential prerequisite to the development and use of principal structural elements of the language system itself.

Though the acquisition of vocabulary was surprisingly once considered "a neglected backwater in second language acquisition" (Meara 2002: 393), attitudes of researchers, particularly since the publication of influential works such as Paul Nation's *Teaching and Learning Vocabulary* (1990) have been transformed (Meara 2002). General consensus amongst modern language researchers is that of all the language skills required in the learning of a new language, knowledge of vocabulary is indispensable, as it provides the essential building blocks upon which the four major language skills, reading, writing, speaking, and listening, are built (Godwin-Jones 2010; Schmitt 2008, 2010; Nation 2013; Nguyen & Khuat 2003). Nation (2013: 570) regards knowledge of vocabulary as being complementary to the four major language skills, as vocabulary knowledge facilitates language use, while language use itself simultaneously encourages the expansion of vocabulary knowledge, creating a positive feedback loop. Indeed, the quotation from Wilkins at the beginning of this section highlights the fact that rudimentary communication can be achieved through the use of vocabulary alone, showing the crucial role that knowledge of individual words and formulaic sequences plays in

the language system as a whole, and the corresponding importance of vocabulary knowledge in SLA specifically (Brown 2001).

It is clear therefore, that the teaching of vocabulary is both a major task for educators, and one of the fundamental challenges facing any SLL engaged in the learning of English as a second language (Nagy 1988). Though vocabulary knowledge is admittedly, only one of many important components of the language system, it can nevertheless be viewed as an essential enabler of the major language skills (Nation & Waring 1997). Vocabulary learning is thus a challenging but essential task, central to the learning of any language (Swan & Walter 1984), the complete understanding of which can significantly improve success in SLA.

3.1. Defining vocabulary

The Greek word *lexis*, literally translated as *word* in English, refers to "the total stock of words in a language" (Lexico.com). Studies have tended to base their definitions of *vocabulary* upon an understanding of *lexis*, which Barcroft, Schmitt and Sunderman define as meaning "the entire vocabulary of a language" (2011: 571). Additionally, the synonymous nature of the three terms *lexis*, *lexicon* and *vocabulary* have been highlighted in the literature (Jackson & Amvela 2000: 11), while Schmitt defines a *word* as being "a basic lexical unit" (Schmitt 2010: 8), giving further credence to popular interpretations of *vocabulary* such as Hornby's frequently quoted definition, "the total number of words in a language […] a list of words with their meanings" (Hornby 1995: 1331). Therefore, it would appear by considering the above, that a simple definition of vocabulary which acknowledges its separation into single words, each with their attributed meaning (or multiple meanings), and the full list of which is representative of the entire body of words and thus, of meanings within a language system, would be an adequate proposition for a workable definition.

It must be noted here however, that *lexical units* (Schmitt 2010: 8) do not always consist of single words but may also constitute combinations of words that express a single *unit of meaning* or a single *idea*. Therefore, when discussing vocabulary, it is much more conventional to refer to *items of vocabulary* than to single *words*. The situation is further complicated when upon delving into the literature we find multiple different terms utilised to describe different aspects of meaning creation and the myriad different ways in which words and their combinations relate to one-another. Terms such as *lexeme*, *formulaic expression*, *chunk*, and *multiword unit* have all been used in the literature to handle the description of idioms and

phrasal verbs and to deal with the lack of one-to-one correspondence between single words and their meanings (Schmitt 2000). What emerges from this milieu is that the various terms mentioned above generally refer to what can be described as "a single meaning unit, regardless of the number of words it contains" (Schmitt 2000: 2). Thus, it can be concluded that *items of vocabulary*, be they single words or combinations of words, can be considered as being *lexemes*, *lexical items*, or *lexical units* (Schmitt 2000: 2), each conveying single ideas, concepts, or units of meaning. These *lexemes* can be utilised in the expression and conveyance of meaning by the speaker, and can be composed of single *words,* or, can be instances of *formulaic language* or *formulaic sequences* (Schmitt & Carter 2004) such as verbs, fixed phrases, compounds, phrasal verbs or idioms (Schmitt & McCarthy 1997).

It can be concluded from this short discussion that far from being simply a list of single words, each with their corresponding meaning/s, stored within what has been described as "a library, an encyclopaedia" (Hedge 2000: 122), the *mental lexicon*, as it is termed, is a complex and multifaceted network, or web of meanings, organised in semantic clusters (or lexical sets) allowing cross referencing across multiple different characteristics such as semantic fields and phonetics (Hedge 2000: 122). This observation has important implications for the teaching and learning of vocabulary, which will be duly addressed.

3.2. Vocabulary size

Before moving on to discussing these implications however, and in order to gain a clear picture of the size of the learning task which confronts both educators and SLLs of English in terms of the teaching and learning of vocabulary items, and to allow the setting of reasonable vocabulary learning goals, it is necessary to estimate the size of vocabulary that SLLs of English need to acquire in order to achieve proficiency in the English language (Nation & Waring 1997: 6). With reference to this study, an accurate estimate coupled with recent growing consensus amongst researchers of the importance of the acquisition of a wide range of vocabulary would give educators and course designers a firm idea of the size and importance of the task that EFL learners are faced with and support the argument for the introduction of pedagogical techniques that may in any way be shown to aid in this endeavour. Such an estimation can be made by briefly addressing three main questions, namely, the total number of words in the English language, how many words native speakers have *knowledge* of, and how many words it is necessary for SLLs to acquire in order to achieve specific language goals.

Concerning the first question, estimations of the total number of word families contained in the third edition of Mariam Webster's International Dictionary of English (1963) have suggested that it contains about 54,000 base words when excluding proper words, compounds, affixes and homographs (Goulden, Nation & Read 1990). This number can be said to be representative of over 1,000,000 individual word forms (Michel et al. 2011), yet it is accepted that native speakers generally only have knowledge of a fraction of these (Schmitt 2000, 2010).

When considering the vocabulary size of native English speakers, estimates have varied considerably, however modern studies have tended to converge on a similar figure. English native-speaker monolingual university undergraduates have been estimated to have *receptive knowledge* (see section 3.3. below) of around 10,000 word families, which include all regular inflections (Milton & Treffers-Daller 2013: 151). Word families are understood here to be *semantic clusters* or *lemmas* (Nation 2013) consisting of a base word, its inflected forms, and regular derivatives (Nation & Waring 1997).

Although the figure of 10,000 word families quoted here may appear already to represent a formidable learning task for a SLL of English if their language goals extend to the levels of what could be termed mastery of the language, to form a complete picture it must be noted that monolingual English-speaking university undergraduates struggle with the reading of academic texts, showing that the level of language proficiency required in academia requires command over a much larger range of vocabulary (Milton & Treffers-Daller 2013: 168). This finding corresponds with earlier estimations of the vocabulary size of well-educated adults following completion of higher education, which have been approximated to vary between a size of 17,000 base words (Goulden, Nation & Read 1990: 341) and 20,000 (Nation & Waring 1997: 6-20). These figures are further corroborated by Schmitt, who puts the figure at 16,000 to 20,000 (Schmitt 2010: 6).

Regarding the third question concerning the extent of vocabulary knowledge necessary in order for a SLL of English to achieve particular language goals, though it has been rightly pointed out that it is necessary to exercise caution "when seeing native speakers' language proficiency as a goal for L2 learners" (Nation 2013: 13), in a study based on British National Corpus data, Nation also suggested that knowledge of 8,000-9,000 high-frequency word families is needed in order to gain lexical coverage of 98% of the words contained in English newspapers and novels, while 3,000 to 4,000 word-families provides the reader with around 95% lexical coverage (Nation 2006). Incidentally, lexical coverage of between 95% and 98% has been

shown by researchers as being inconsequential to general language comprehension (van Zeeland & Schmitt 2013: 457). It has also been concluded that for a SLL of English to successfully read the majority of common English text types, a vocabulary size of around 8000-9000 word families is required, with this number dropping to around 5000-7000 word families when one considers proficiency in conversational abilities (Schmitt 2008: 329; Milton 2009: 234). Thus, knowledge of 10,000 word families can be considered to be a minimum, but by no means adequate requirement for higher education, representative of proficiency but not mastery. However, for a SLL of English to be successful in general language tasks such as daily conversation and the reading of authentic texts, the size of vocabulary knowledge necessary is considerably less.

In conclusion, with reference to the number of word families that it is necessary for a SLL to have knowledge of in order to enable them to use the English language to achieve the majority of their language goals, Nation and Waring referenced major studies conducted in the 1980s and 1990s and concluded that it would be necessary for a SLL of English to achieve a vocabulary size of between 3,000 and 5,000 high-frequency word families to provide them with "a basis for comprehension" (Nation & Waring 1997: 10). With regards to listening comprehension, this figure has been estimated to be much lower, at a level of 2,000 to 3,000 to achieve lexical coverage of 95% (van Zeeland & Schmitt 2013: 457). Considering a learner with a vocabulary size of 2,000 word families is able to comprehend 80% of the words during the reading of any given English text (Schmitt & McCarthy 1997: 6-20), 4,000 are necessary to comprehend 95% (Nation 2006: 72), and 6,000 to 9,000 are necessary to enable 98% lexical coverage (Nation 2006: 72), a vocabulary size of 3,000-5,000 word families would put a SLL in a strong position to enable general comprehension and the educated guessing of meaning when it comes to unknown words (Nation 2013: 515).

As a closing comment, it must be noted here that the studies above have mostly looked at what is termed receptive knowledge, or receptive vocabulary knowledge, and do not refer to productive vocabulary knowledge. This difference will be discussed below.

3.3. The building of meaning – defining vocabulary knowledge

What does it mean to *acquire* an item of vocabulary, and at what point can it be confidently stated that it is *known*? Researchers agree that the answering of these questions is no simple matter (Schmitt 2010; Carter & Nunan 2001), and Schmitt highlights the fact that "there is currently no overall theory of vocabulary acquisition" (Schmitt 2010: 97). For Thornbury (2002), mastering vocabulary is equal to the possession of a comprehensive set of skills requiring knowledge that enables the learner to not only recognise and use the spoken and written forms but also includes knowledge about the grammatical behaviour of the item, its collocations with other words in the lexicon, connotations and associations, and the frequency of the item (Thornbury 2002).

A philosophical discussion of this predominantly epistemological subject is naturally beyond the scope of this study, however, a short discussion here on how it is we can define lexical knowledge so that it may be possible to state with a measure of confidence that a word has indeed been *acquired*, will certainly be of benefit, if only in that raising the issue could help in suggesting lines of further research in the area in order to broaden the discussion. It will briefly suffice to say here then, that the traditional view of one-to-one fixed word-meaning relations has certainly been questioned in the literature and the view of philosophers of language such as Wittgenstein, that words do not acquire their meaning through relation to single concepts, leads to the accepting of the premise that "a word is defined by its use in a wide range of contexts" (Burgess & Lund 1997: 203). A review, therefore, of the related literature will be given here with the aim of collecting together the suggestions of different researchers and combining them to provide a rough framework which may guide further discussion.

The complexity of English vocabulary has been noted by Nation and Meara, who highlight its three main characteristics, namely *form*, *meaning*, and *use*, which further display deeper layers of meaning related to word roots (Nation & Meara 2010: 34). Thus, learning a vocabulary item and mastering its use is thought to constitute a great deal more than the simple recognition of its written or spoken form. Nation for instance, regards "learning a word [as] a cumulative process involving a range of aspects of knowledge" with learners requiring "many different kinds of meetings with words in order to learn them fully" (Nation 2013: 4). Implied here therefore, is the notion that vocabulary acquisition comprises an element of *depth*, and that an increasingly deep level of learning, or cognitive analysis, enables progressively more effective language use. A *vocabulary item,* therefore, can either be learned to a maximum degree, or to

progressively lesser degrees, as Nation states; "there are many things to know about any particular word and there are many degrees of knowing" (Nation 2013: 44).

These aforementioned *degrees* can be seen as ranging from the mastery of an item across all grammatical patterns, collocations, usage constraints, syntactic and pragmatic patterns, semantic networks and patterns of discourse involving aspects such as register and frequency, to simple recognition of an item's form in both written and spoken language (Laufer & Goldstein 2004; Schmitt & Zimmerman 2002; Carter & Nunan 2001). For Nation; "knowing a word is taken to include not only knowing the formal aspects of the word and knowing its meaning, but also being able to use the word" (Nation 2013: 4). Therefore, *vocabulary knowledge* can be viewed as a sum of the interrelated elements of connected meaning, and to have knowledge of a vocabulary item involves acquiring knowledge of all its different elements, its *form*, its *meaning*, and additionally of the ways in which it is possible to successfully *use* the item (Nation 2013: 48).

This observation leads naturally to considerations of the different classifications of English vocabulary that have been generally described by researchers, as *forms*, *meanings*, and *patterns of usage* differ widely from item to item, and additionally, a spectrum, or scale of *knowing* can be observed to exist across these three factors extending from form, through to usage (Nation 2013; Schmitt 2010; Hedge 2000). Taking this into consideration, researchers have generally made a distinction, at the most basic level, between two different types of vocabulary, demarcated by the cognitive depth at which their meanings have been processed. This depth in turn has been shown to determine the extent to which a language user can recognise and use a given vocabulary item.

The distinction in question is generally made between *passive* and *active* vocabulary, referring to vocabulary items that a language learner is able to recognise and understand when presented with their forms but is unable to actively use, and vocabulary items they are able to successfully use when engaged in different modes of language use respectively (Meara 1980; Nation 2013; Schmitt 2010). Others have made a similar distinction, though different labels have been applied, namely *receptive* and *productive* vocabulary (Hedge 2000: 116). However, it has been noted that there is little concurrence between researchers in the application of these terms and that they have generally been used synonymously (Nation 2013: 47).

Essentially, however, the same observation is being made here, namely that a language learner is able to initially recognise the formal elements of vocabulary items *before* they are able to

recall the precise meaning of those items from memory, and ultimately before they acquire the ability to successfully use items in active language skills. This would suggest that it is easier to acquire vocabulary to a *passive/receptive* degree than it is to attain an *active/productive* level of vocabulary knowledge, and correspondingly, that a language learner's stock of *passive/receptive* vocabulary would therefore be larger than the number of *active/productive* items. Indeed, there is ample research that bears out this hypothesis (Webb 2008; Laufer 1998; Waring 1997a, 1997b), and scores on receptive tests of word retention have been shown to be significantly higher than scores on productive retention tests (Griffin & Harley 1996), pointing to a fundamental characteristic of the progressively deeper nature of the cognitive processes that take effect as a language learner gradually progresses along a continuum from the *recognition* of an item's form, to deeper levels of *knowledge* of an item of vocabulary. Indeed, it has been suggested that productive learning may be more difficult than receptive learning for precisely this reason, as it requires more elaborate cognitive processing to achieve better retention (Aitchison 2012). This topic will be addressed further below when discussing theories of memory and the *Depth of Processing Hypothesis* in particular (see section 3.6. below), as it has been shown that this phenomenon is representative of the result of differing depths of cognitive analysis.

Whilst a basic distinction between *passive/receptive* and *active/productive* vocabulary allows a certain level of insight into the processes at work in vocabulary acquisition, it has been pointed out that these terms unfortunately do not tell the entire story when it comes to adequately describing exactly what is occurring when a language learner first learns to recognise an item's form and then gradually learns the intricacies of related usage (Nation 2013; Hedge 2000; Meara 1990). Indeed, Hedge has described this dichotomy as being "too simple a characterization" (Hedge 2000: 116). The term *passive* for instance, usually refers to the language skills of listening and reading; however, researchers have pointed out that active elements are involved in both active and passive language skills (Hedge 2000). As a result, Nation chooses, in keeping with Schmitt (2010), to use the terms *receptive* and *productive*, along with the additional 4 terms of *meaning recognition* and *meaning recall* with relation to receptive vocabulary knowledge, and *form recognition* and *form recall* with reference to productive knowledge (Nation 2013: 47), to more adequately describe the cognitive processes at work. He then proceeds to describe the differences thus; "receptive vocabulary use involves perceiving the form of a word, while listening or reading and retrieving its meaning. Productive

vocabulary use involves wanting to express a meaning through speaking or writing and retrieving the appropriate spoken or written word form" (Nation 2013: 47).

The picture that emerges from this discussion is that ultimately, vocabulary knowledge can be regarded as occurring along a continuum that relates to the depth of cognitive processing undergone by the item, and that this continuum is incremental in nature (Nation 2013: 42-53). An additional observation that can be made from the point of view of the language learner as a *perceiving subject*, is that, speaking from a cognitive psychological perspective, both bottom-up and top-down cognitive processes are clearly involved here (Lockhart & Craik 1990), and that the perceiving subject is, from a cognitive point of view, involved in two separate processes which Nation's distinctions, elaborated above, appear to adequately capture.

If we apply this observation to Nation's chosen terminology, then it can be seen that in the case of receptive vocabulary, meaning recognition and recall proceeds from the received form (bottom-up), whereas in the case of productive vocabulary, form recognition and recall proceeds from stored meaning or form (top-down), thus shedding light on why exactly it is that the deeper the cognitive processing of an item and corresponding knowledge of its precise meaning and the stronger the respective connections that have been forged between the item and the related elements of the mental lexicon and semantic network of the language learner, the more effective its usage.

Regarding the exact nature of the hypothesised continuum of vocabulary knowledge, and therefore of the dimension of depth involved, Deane et al. (2014) suggest a *4-step path to semantic knowledge* that describes a normal sequence of inferential processing hypothesised to occur from a SLLs' first encounter with an item of vocabulary, and ultimately "result in the gradual consolidation of a semantic/conceptual representation integrated with background knowledge" (Deane et al. 2014: 2). Acknowledging that this 4-step sequence is more suited to the implicit acquisition of vocabulary items rather than explicit learning (see section 3.7.1. below), Deane et al. list the following four stages; namely, *familiarisation with patterns of usage*, *development of appropriate semantic memory representations*, *development of appropriate conceptual representations*, and *consolidation of conceptual representations with world knowledge*, as being representative of the stages of cognitive analysis involved as a newly learned vocabulary item gradually becomes embedded within the language system and cultivates connections throughout the mental lexicon of the learner to successively deeper degrees that are richer in both number and quality (Deane et al. 2014: 2).

To bring this discussion to a conclusion, it appears that there are a number of different dimensions that are involved in vocabulary acquisition and therefore that contribute to the construct of *vocabulary knowledge*, a short elaboration of which will facilitate later discussion concerning vocabulary acquisition and the extent to which an item of vocabulary can be said to be *known*. Although well beyond the scope of this paper to provide a comprehensive description, and in consideration of the fact that an accepted, standard theory of vocabulary acquisition does not yet exist (Schmitt 2010: 116), a tentative attempt will be made here to set the boundaries of a workable framework within the confines of which this research paper may proceed, however, with the full knowledge that this framework cannot hope to be complete and may well turn out to be inadequate.

In summary then, it can be seen that vocabulary acquisition and its corresponding mastery occur along a scale, or a progressive continuum, distinguished by successively deeper levels of cognitive analysis which result in stronger and more complex connections both between the *form* and the *meaning* of the items themselves, and between their respective conceptual representations and other parts of the language system constituting the mental lexicon and the speaker's general semantic network. Thus, a *depth dimension* may be hypothesised that is representative of the quality of cognitive processing that has taken place with relation to individual vocabulary items and thus the general quality of the connections that have been forged in LTM. This proposed depth dimension, as it relates to vocabulary acquisition, has been shown by researchers to be related to the phenomenon that vocabulary items are recognisable and understandable as a result of meaning recognition and recall when the form is given, before their forms are reproducible by the language learner in active language use. Thus, an additional second dimension that may be referred to as a *receptive/productive dimension* may also be hypothesised and can be regarded as being directly related to the depth dimension. Finally, although useful for the representation of the language comprehension and production abilities of language learners, the terms *receptive* and *productive* have been criticised for their inability to fully capture the exact nature of the cognitive processes of semantic inference involved as a SLL gradually acquires and learns to use an item of vocabulary, as this dichotomy does not take into account the information available to those processes. Thus, it may be concluded here, that there exists a third related dimension contributing to the construct of *vocabulary knowledge*, that can be viewed as being representative of a dimension of quantity rather than of quality as in the depth dimension, and that this dimension results in progressively more precise comprehension as more numerous

connections are formed and strengthened within the LTM of the language learner. As more knowledge about a vocabulary item is acquired therefore, the initial vague understanding of the item's meaning gradually gives way to progressively more focused and precise comprehension as further shades of meaning are analysed and consolidated in LTM, which in turn of course, allows progressively deeper inferences to be made and thus a deeper understanding of the vocabulary item to be achieved. These three dimensions of vocabulary knowledge, namely the *depth dimension*, the *receptive/productive dimension*, and *partial/precise dimension*, were initially proposed by Henriksen (1999: 304) and as can be seen, this multi-dimensional conception of the construct of vocabulary knowledge has been extensively supported by the literature highlighted above.

In conclusion, by combining distinctions made by Nation between meaning recognition and recall, and form recognition and recall (2013) to adequately capture the nature of bottom-up and top-down cognitive processes at work in vocabulary acquisition, along with the 4-steps to semantic knowledge delineated by Deane et al. (2014) to fully explain the cognitive stages of semantic inference involved in the depth dimension related to vocabulary knowledge, and finally, as an overall structure, Henriksen's three dimensions of vocabulary knowledge (1999) into a workable framework, this paper can comfortably proceed to describe and discuss the continuum of vocabulary knowledge as it relates to the question of what it means to acquire an item of vocabulary and to ascertain the differing levels at which a SLL can be said to possess *knowledge* of that item.

3.4. The role of cognition and memory

Human cognition and memory play pivotal roles in *language acquisition* and in the learning of new vocabulary. As a result, general psychological models of memory can be shown to be importantly related to word-learning processes. However, there is unfortunately no single explanatory theory concerning exactly how the processes involved in the learning of new vocabulary items, whether in a foreign language or in the language learner's mother tongue, relate to general cognitive processing systems (Gaskell & Ellis 2009: 3613). Therefore, at present, the exact role of cognition and memory in SLA must be considered an area of ongoing research. However, relevant theories will be briefly outlined here in order to gain a picture of current understanding relating to the functioning of the human mind as it sets about the business of identifying, codifying, storing, and recalling vocabulary items.

3.4.1. Types of memory

A primary, structuralist distinction is normally made by cognitive psychologists, between *working memory* (WM), containing a functional module known as *short-term memory* (STM), and *long-term memory* (LTM) (Altarriba & Isurin 2013; Baddeley 2010). Although there is much disagreement in the field as to the exact nature and functioning of these separate components, research to date seems mainly to support what is essentially one of psychology's oldest ideas, evident even in the writings of William James in his seminal work *Principles of Psychology* (1890) and later reintroduced by Broadbent (1958), namely, a functional distinction between two types of memory based upon the span of time during which information is accessible to consciousness (Altarriba & Isurin 2013).

It should be noted here before continuing, that a structuralist view of memory and cognition, constituting separate stores and modules all performing distinct functions, is not the only view that may be taken to the functioning of human memory. A procedural view on the memory system such as that supported by Craik and Lockhart in the elaboration of their *levels of processing hypothesis* (1972) has also been suggested, however, such viewpoints have proven to be less prevalent in the literature. The preference however, for one or the other means of formulating functional descriptions of information processing as it relates to memory, can be seen as just that, a preference for a particular approach, as the following extract from Lockhart and Craik exemplifies;

> Of course there must be structures at the neurological level sustaining the procedures; but, in terms of hypothetical mechanisms at the cognitive level sustaining the procedures, we see no need to posit structural mechanisms intervening between procedures and their neurological substrates. (Lockhart & Craik 1990: 94)

In consideration of these two viewpoints on the functioning of memory, a structuralist approach will be taken to explanation here, and the distinction between separate WM and LTM stores will be used as a functional metaphor that will guide following discussion, though a procedural approach is deemed no less valid or to have less explanatory power.

These two memory types then, are each based upon the functioning of two distinct stores; a short-term store of limited capacity that controls access to and provides the coding for LTM (Atkinson & Shiffrin 1968), and which "provides a temporary store in which the various components of WM, each based on a different coding system, can interact through participation in a multidimensional code, and can interface with information from perception and long-term memory" (Baddeley 2010: 138), and a relatively permanent LTM store of currently unknown

capacity (Voss 2009). However, unfortunately, it is here that consensus between many structuralist researchers ends.

3.4.2. Long-term memory

At its very basis, "[l]ong-term memory (LTM) contains stable representations of knowledge acquired over time, including explicit memory for facts and events, and implicit memory for skills, routines, and associations" (Altarriba & Isurin 2013: 9). The distinction between explicit and implicit memory is clearly made here at the level of consciousness to denote the difference between the parts of our mental lives which can be recalled from LTM and made conscious, and those parts of LTM which relate to internalised patterns residing in our sub-conscious, yet the existence of which is only demonstrable by changes in ability due to further internalisation of information, or, in other words, due to further learning (Altarriba & Isurin 2013). This distinction is however, not simply a theoretical one. Many studies have shown the dissociation of neural circuits involved, suggesting that during recall, the brain must query disparate mental architectures (Poldrack & Packard 2003; Voss & Paller 2008).

With relation to the language system and SLA in particular, both explicit and implicit memory make fundamental contributions to the cognitive processes involved in the processing of new information and in subsequent query and recall during language production. Implicit memory for instance, has been shown to play a pivotal role in grammar acquisition (Ullman 2004), while explicit memory has been linked with both SLA and bilingual cognition in general (Pavlenko 2000). Explicit memory itself is further separated into lexical/semantic memory, which refers to the storage of information referring to general facts such as word-meaning associations, and episodic memory, which contains information pertaining to events and the linguistic environment in which they occur (Altarriba & Isurin 2013).

Concerning the processing and encoding of semantic and episodic memory and its subsequent transfer to LTM, or in other words its consolidation in LTM, competing theories abide (Altarriba & Isurin 2013: 11). Memory consolidation theory regards semantic and episodic memories as being formed in disparate neocortical areas and being bound together or consolidated through the hippocampus (Paller 1997). Evidence for this model comes from patients with hippocampal lesions who display impaired functioning when attempting to combine novel semantic and episodic memories yet can seamlessly recall prior facts and events that were presumably consolidated before their injuries (Scoville & Milner 1957). Alternatively, multiple trace theory holds that these processes are separate, with semantic

memory residing instead in the neocortex, whilst episodic memory remains dependent upon the hippocampus (Moscovitch et al. 2005: 35).

Three main questions are of interest here in terms of their relevance in SLA. Firstly, the nature of the encoding processes at work and the resulting consolidation of novel language and linguistic information into LTM. Secondly, the question of independent or separate storage of semantic and episodic memory in LTM. And thirdly, subsequent recall of language from LTM. These questions will be addressed following a discussion of WM.

3.4.3. Working memory

> Working memory may be defined as the system for the temporary maintenance and manipulation of information necessary for the performance of such complex cognitive activities as comprehension, learning, and reasoning. (Baddeley 1992b: 281)

Of the theories on WM there are two which to-date continue to dominate the literature, namely, Cowan's *unitary store* model (Cowan 1998), and Baddeley's *multiple-store* model (Baddeley & Hitch 1974). In short, Cowan's model holds that the two systems of STM and LTM are based on the same fundamental neural circuits, with STM representing the reactivation of representations in LTM (Shiffrin & Atkinson 1969). Baddeley's model on the other hand proposes the existence of a multiple-store model of WM, which he terms *multicomponent working memory* (M-WM), that consists of separate neural components comprised of further sub-divisions responsible for the processing of particular aspects, both concrete and abstract, of sensory information (Altarriba & Isurin 2013).

For Cowan and other supporters of unitary-store models, the contents of STM are simply the reactivation of representations stored in LTM (Cowan 2000: 104). This assumption has implications for the capacity of such models, as the number of items that can be activated at any one time is thus determined by attention (Cowan 2000: 106). For Baddeley's model however, the capacity of M-WM is determined by the interplay between the natural decay of short-term representations and the limits of the mechanism responsible for rehearsal. Capacity in M-WM is thus, the point at which the speed of rehearsal cannot keep up with the natural rate of decay of the representations that have been made (Baddeley 1992a, 1992b). For reasons of brevity, and the observation that Baddeley's model of M-WM makes specific allowances for phonological processing, therefore resulting in its more frequent and specific application to

language acquisition, Baddeley's model will be elaborated here and used in further discussion, however, no claim is made here as to the efficacy of either model.

Initially proposed by Baddeley and Hitch (1974), M-WM takes a modular approach to memory, and assumes the existence of four sub-components, namely the *central executive*, the *phonological loop*, the *visuo-spatial sketchpad*, and the *episodic buffer* that are hypothesised to comprise a STM store that deals with incoming sensory information before it enters LTM (Baddeley 2017: 299). Baddeley describes M-WM as being of limited capacity (Baddeley 2010: 137), and sees it as "the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension and learning" (Baddeley 2010: 136). He also regards its functioning as an integral part of SLA (Baddeley 2017: 303).

Since its inception, the model has gone through many revisions in light of the continual development of cognitive psychological research. As this model has survived for well over 30 years now, and "has proved a useful theoretical framework for investigating a wide range of human activities" (Baddeley 2010: 140) it can be confidently employed here as a suitable structuralist model that can be applied to the discussion of later results. Figure 2 shows the most recent conception of the model, representing external signals entering the senses from the bottom up, and the top-down nature of the central executive as it relates to the episodic buffer.
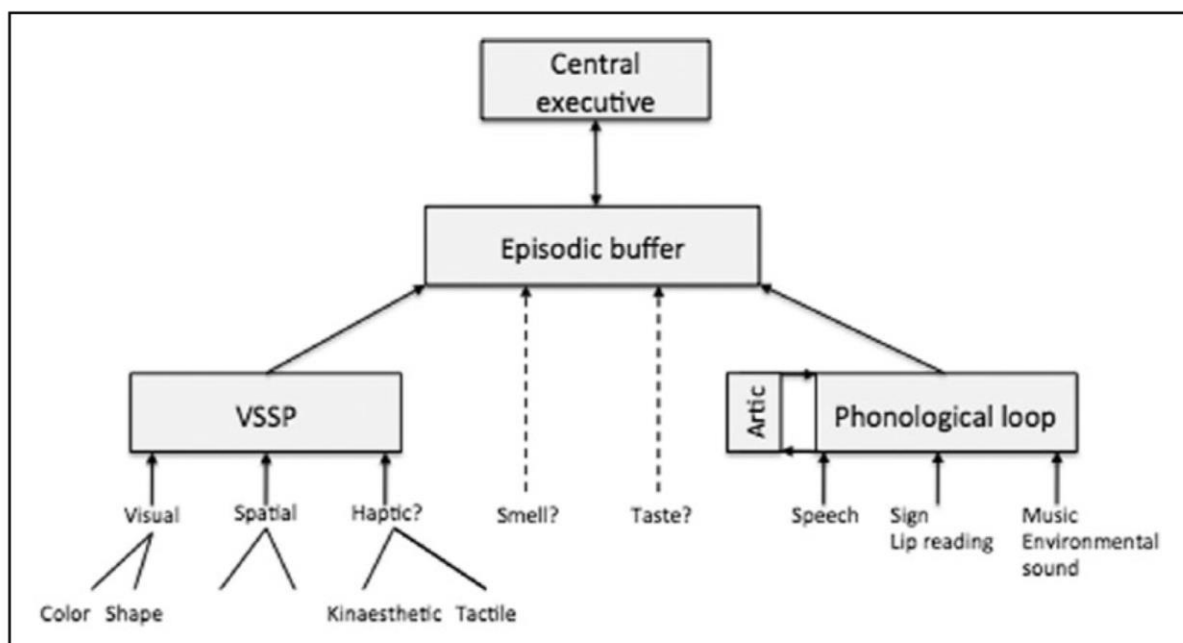
Figure 2: Baddeley and Hitch model of the Multicomponent Working Memory (Baddeley 2017: 307)

Details of the exact functioning of the model are complex, therefore, it is preferable here to leave Baddeley to explain;

> It [the model] attempts to capture the flow of information within the verbal and visual domains, from perception to working memory, with individual tributaries, from visual, spatial and tactile information combining and being bound into integrated visuo-spatial representations within the sketchpad [VSSP], which in turn can be bound into multidimensional episodes within the buffer. Similarly, streams of auditory-verbal information can be combined with other non-auditory language-related information within the broad phonological loop domain […], combining with semantic and syntactic systems in LTM. Both visual and phonological domains are then assumed to influence conscious awareness through the episodic buffer. The episodic buffer in turn uses this information to feed back and control perceptual input and to combine with information from LTM to plan, control and execute future action. (Baddeley 2017: 306)

Evidence for part of the role played by the M-WM in language acquisition comes from studies of patients with phonological loop impairment. Such individuals have been shown to experience little trouble learning meaningful language material, however, exhibit severe deficits when it comes to learning L2 vocabulary (Baddeley, Gathercole & Papagno 1998). Following a review of relevant studies, Baddeley, Gathercole and Papagno have suggested that "the primary purpose for which the phonological loop evolved is to store unfamiliar sound patterns while more permanent memory records are being constructed" (Baddeley, Gathercole & Papagno 1998: 158). The authors, therefore, are of the opinion, that this particular module of the M-WM is responsible for the generation of mental representations from the phonological information provided by both familiar, and unfamiliar speech, namely new words (Baddeley, Gathercole & Papagno 1998: 158), the perception and maintenance of phonological form being an important initial stage that precedes codification and consolidation in LTM (Altarriba & Isurin 2013: 25).

3.5. The cognitive process of second language acquisition

In terms of the question of encoding processes at work in M-WM and subsequent consolidation in LTM, it may be seen here that there are a number of factors at play, and at the head of this process is the factor of attention or engagement. Once the SLL is engaged with the language material to be learned, a number of factors related to SLA begin to exert their influence on the encoding processes at work in M-WM. Principles specifically related to vocabulary acquisition such as *repetition, spacing, pacing, use, cognitive depth, organisation, imagining,* and *mnemonics* all play their part in the initial encoding process (Nation 2013). These principles have been shown in previous studies to contribute to the process of moving information linked with an item of vocabulary into permanent LTM (Thornbury 2004), and it naturally follows

that memory strategies for the learning of vocabulary, which will be discussed below, should attempt to leverage these principles to make the processes of learning, and subsequent retrieval of vocabulary items more efficient and effective.

Nation (2013: 102) highlights three cognitive processes involved in determining whether a vocabulary item is remembered, namely, *noticing*, *retrieval*, and *generative use*. Noticing is clearly linked with motivation and therefore with a language learner's directed attention, which can be considered as being goal-directed, and therefore, as having been assessed as meaningful and worthwhile by the language learner (Nation 2013: 437). Schmitt (2008: 329) for instance, concluded that "[t]he overriding principle for maximising vocabulary learning is to increase the amount of engagement learners have with lexical items". Whichever factor one observes when assessing vocabulary acquisition, the most important according to Schmitt is the amount of what he terms *engagement* that a learner has with the vocabulary item, as "anything that leads to more and better engagement should improve vocabulary learning" (Schmitt 2008: 339).

Once having engaged with and attended to the target language, it becomes clear that the encoding process within M-WM is significantly influenced by repetitions, and that repeated exposure to vocabulary items is necessary to achieve the required movement of information into LTM, as a vocabulary item naturally cannot be fully learned after only a single encounter (Nation 2013; Horst, Cobb & Meara 1998; Jenkins, Stein & Wysocki 1984). Estimates of the number of individual encounters a language learner must have with an item of vocabulary vary considerably, from as low as six (Rott 1999), to estimates of more than ten repetitions or rehearsals (Pigada & Schmitt 2006). Randall views repeated encounters with new vocabulary, or rehearsal, as being the major factor determining the initial storage of information in LTM (2007: 169). Retention rates for newly learned vocabulary are therefore positively correlated with the number of repetitions (Randall 2007). Essentially, the more repetitions made, the stronger the impression formed, the greater and deeper the consolidation in LTM and therefore better the resulting retention and subsequent recall of the vocabulary item (Randall 2007: 127).

Physical evidence for the effect of repetition and the forging of connections between word and meaning in LTM comes from functional magnetic resonance imaging studies of neural pattern similarity. Xue et al. provided such evidence in the detecting of the neural mechanisms responsible for the long-term encoding of the new meanings in memory. The researchers concluded;

> Taken together, our results suggest that episodic memory encoding is enhanced by reactivating the initial neural representation in each subsequent study episode. […] our data suggest that pattern reinstatement can account for subsequent memory effects for both verbal and non-verbal materials, and in both recall and recognition tests. (Xue et al. 2010: 100)

A related factor to that of rehearsal, is the issue of the *spacing* of repetitions, an aspect of vocabulary learning that was implemented and tested in Chen and Chung's 2008 study reviewed above (see section 2.2.2. above). Schmitt and McCarthy suggest "reviews of five to ten minutes after the end of the study period; then one week later, one month later, and finally six months later" (1997: 216). While Wenden and Rubin are of the opinion that shorter and more frequent periods of study are superior for learning than long and intense periods (Wenden & Rubin 1987). Schmitt suggested that "most forgetting occurs after […] learning sessions" and therefore repetitions "need to occur quickly" (2008: 343). Though exact timings will depend ultimately upon individual differences in addition to unique situational and contextual differences at the point of each individual encounter, what remains significant for the discussion is that there appears to be an optimal spacing of repetitions at a time-interval that is not longer than natural processes of decay begin to take effect and erode previously constructed mental representations in LTM.

Forgetting items, or what has been termed *information decay* can occur over longer periods of time. The speed at which this occurs depends on a number of factors and can be a result of individual differences in *basal forgetting rates*, physiological factors effecting attention such as lack of sleep or stress, and with specific interest for this study, the presentation methods used during the encoding process (Chen & Chung 2008). The forgetting of vocabulary which has already been learned is of course, one of the major problems facing the language learner. Strategies for overcoming the shortfalls of memory have been classified into four separate categories; the employment of actions during encoding, application of images and audio, creating mental connections, and reviewing (Oxford 1990a). Here again, it appears that a language learner can employ many different general strategies at the point of encoding that can significantly mitigate against the effects of information decay and natural basal forgetting rates, in order to maximise the efficiency of the entire process of vocabulary acquisition, and one of these strategies is certainly repetition or rehearsal of vocabulary items at the most opportune time-intervals.

Concerning modes of encoding, there are of course multiple ways in which our brains encode information for later recall, and thus which can affect the efficiency of the recall process

(Longcamp et al. 2006: 646). From the discussion so far, it is evident that representations or impressions of vocabulary items must be meaningfully stored in LTM, establishing strong links with other areas and items in the mental lexicon (Arias 2003). There are of course many strategies that a language learner can employ to aid the process of meaningful storage in LTM. Naturally, flashcards, which have been generally championed by language researchers (Nation 2013; Laufer & Yano 2001; Editorial 2005) have proven to be effective memory aids (Nation 2013: 468). As mentioned above, linking vocabulary with pictorial representations has also proven to be a useful way of elaborating the information connected with a vocabulary item during the stages of consolidation in LTM and providing visually linked neural pathways to vocabulary representations. Association with visual cues has been described as "highly useful for those learners who are visually oriented" (Arias 2003: 118). Linking memories of vocabulary items with pictorial representations harnesses the strength of effect that pictures have on human memory, which has also been tested digitally and shown to have a similar success-rate (Oberg 2011; Oberg & Daniels 2013).

Studies of memory recall provide insight into the ways in which linguistic memories become encoded in LTM. For example, studies of bilingual episodic memory, namely the types of memories that contain information concerning context, linguistic context, sensory detail etc. have shown that memories are encoded along with their linguistic context in either of the languages spoken, and that "these linguistic characteristics are stable properties of those memories over time" (Schrauf & Rubin 2000: 616). Studies such as this shed light on the ways in which memory is organised and the part that language plays in the recalling of non-linguistic memories. Further studies on bilinguals have revealed that a memory recall tactic often utilised is to translate word cues from one language to another if the speaker finds that they cannot recall a specific memory (Schrauf 2003: 235), providing further evidence for the consolidation of language-specific information in LTM and the retaining of language-specific information in episodic LTM which aids in subsequent recall.

This discussion leads to the final major element, namely successful recall from LTM for use in WM. This needs little more elaboration here, apart from to note that in order for this process to be most efficient, sufficient elaboration must have occurred during the memory consolidation and storage processes that resulted in the building of the memory's impression in LTM, and additionally, that an adequate process of gradual elaboration and expansion of formal and semantic connections through successive, optimally spaced encounters with the vocabulary item has occurred since its first impression upon memory. Degree of learning and thus the rate

of successful recall seems to rely far more on the nature of the processing that has already occurred rather than on the mere inputting and holding of information in STM (Baddeley 2010: 137). Retrieval is thus made easier and more efficient the deeper the cognitive processing that has occurred (Baddeley 2017).

Deep cognitive processing of items before categorisation in LTM thus allows the language learner to utilise items of vocabulary in what Nation terms *generative use*, and regards as occurring "when previously met words are subsequently met or used in ways that are different from the previous meeting with the word" (Nation 2013: 68). Production in this sense is additionally split into receptive and productive elements, as Nation points out that "productive recall is more difficult than receptive because there are many competing paths to choose from, and the ones within the L1 lexical system are likely to be stronger" (Nation 2013: 29). Nation has further suggested that the learning of a word is a step-by-step cumulative endeavour (Nation 2013: 119), and this would suggest that it is dependent upon repeated encounters with the item in different contexts, and many different forms of rehearsal, including rehearsal relating to form, meaning, and also to the use of an item.

It has been suggested that "repetition is the principle route to storage in the LTM" (Randall 2007: 169). But it is also the case that repeated use, or, from the point of view of cognition and memory, repeated recall from LTM, also strengthens neural links in the opposite direction as information is transferred to WM and processed meaningfully before being outputted in language production (Altarriba & Isurin 2013). This is supported by the observation that WM in bilinguals is often more efficient, as these neural links communicating back and forth between STM and LTM are being utilised in the transmission of linguistic information to a far greater degree than in the WM of monolinguals (Altarriba & Isurin 2013).

It appears from the discussion above, that upon presentation of a new vocabulary item, an initial impression is made in M-WM and a learner can be said to have discovered the item's *form*. If this initial presentation has occurred during incidental learning, then the impression may only be fleeting or momentary, as the learner continues reading or as the conversation or listening activity progresses. If there is little time for analysis during this time, then deeper analysis of the item will be impossible, and unless a further encounter with the item occurs within a finite window of opportunity, then the item will be less likely to achieve the level of cognitive processing necessary for consolidation and storage in LTM, or if it is stored, the resulting impression will be of lesser quality due to lack of elaboration, and the learner will experience

difficulties when attempting to recall the item later. If on the other hand, the item is being encountered again, or has been presented as part of an intentional vocabulary learning task, then it is presumed that there will be more opportunity for M-WM to process the item to a deeper level of cognitive analysis and that a greater cognitive load will be involved in that analysis. Thus, many more aspects and characteristics of the item will be analysed and consolidated into LTM, giving the impression that is formed a richer and more elaborate nature, and providing the learner with multiple neural pathways of greater strength and of greater speed with which to recall the item in later language use. Following an initial encounter, it is essential that the language learner is presented with multiple further opportunities to consolidate the meaning of the item and refine this meaning in ways which will ensure more precise and successful usage.

Important for this thesis, therefore, is that M-WM has limited capacity. It is the M-WM that is responsible for receiving and processing the relevant information pertaining to new vocabulary items before this information is eventually assimilated into LTM (Randall 2007: 88-90), and it is these initial stages of processing that are of interest in this study as it will be the M-WMs of the participants that are ultimately effected by the methods of learning to be employed later in the experiment to be conducted. These conclusions now lead to a short discussion of what it means to process an item of vocabulary to increasing levels of cognitive depth.

3.6. The depth of processing hypothesis

> The learner must undertake some analysis of the to-be acquired word-meaning complex and must then establish a representation of this complex in memory […] A considerable body of research from other fields demonstrates that the quality of this representation is central to the success or otherwise of subsequent retrieval. (Lawson & Hogben 1996: 104)

To achieve increasing strength of neuronal connections between items of vocabulary and their respective formal and semantic aspects in LTM, repetition can be viewed in light of the discussion above as being essential. However, repetition alone does not tell the entire story with regards to effective vocabulary acquisition. Studies have found that processing the form of a word is much less effective in terms of learning than the encoding of the word in terms of its meaning and the emotional tone connected with the word (Craik & Lockhart 1972). It has additionally been noted that vocabulary must be meaningfully categorised and stored in LTM in order to increase the chance of recall (Pérez & Alvira 2017: 105), highlighting the fact that meaningful connections must be established between vocabulary items and other information

during the storage process. It has also been suggested that the more extensive the elaboration of linguistic material, the greater the chance of its being recalled (Mayer 1992: 408). Observations such as these all build on theoretical foundations supplied by what is known as the *Depth of Processing Hypothesis*.

The Depth of Processing Hypothesis (Craik & Lockhart 1972; Lockhart & Craik 1990) proposes that there are levels of processing involved in the consolidation and storage of information in LTM, and the deeper the level at which information has been processed, the higher is the likelihood that the information will be retained and the easier it will be to recall (Craik & Lockhart 1972). A short extract from Lockhart and Craik concerning the difference between processing an item with respect to its formal elements and processing at a deeper semantic level makes this observation clear; "[j]udging that the word *dog* refers to a domestic animal may lead to its being better recalled than judging that it rhymes with *fog*" (Lockhart & Craik 1990: 94). Thus, it is the depth of cognitive analysis to which a stimulus is subjected upon encoding with regards *semantic involvement*, that directly effects LTM retention rates (Segler, Pain & Sorace 2002; Lockhart & Craik 1990).

3.7. Vocabulary learning strategies

Constructing vocabulary knowledge requires the accumulation of successively more complex, connected, and elaborated facts about many and varied elements related to vocabulary items. Vocabulary knowledge, therefore, includes a wide range of elements, including knowledge of gender, derivation, spelling, pronunciation, idioms, grammatical environment, connotation and collocation (Benjamin & Crow 2010). To aid language learners in the accumulation and gradual acquisition of vocabulary knowledge, authors and researchers have made suggestions concerning activities that learners can employ, known as vocabulary learning strategies.

3.7.1. Intentional learning vs incidental learning

Strategies for learning vocabulary can initially be categorised into one of the following two strands; *incidental learning*, in which the learner learns vocabulary as a result of the inference of meaning during the undertaking of different language activities such as reading or listening, or *intentional learning*, in which the learner undertakes activities specifically focused on the acquisition of target vocabulary items (Nation 2013: 326).

Incidental vocabulary learning refers to the learning of vocabulary as a side-effect, or by-product of participation in other language learning activities. This is done through inference of meaning, which has been shown to play an important role in vocabulary acquisition (Anderson & Freebody 1981; Qian 2002). Gass suggested "that at least some, if not a large part, of one's L2 vocabulary is acquired incidentally—that is, as a by-product of other cognitive exercises involving comprehension" (Gass 1999: 319). Many studies have supported this notion and have shown that extensive listening and reading significantly affect incidental vocabulary learning which contributes to learner vocabulary knowledge and size (Vidal 2011; Hunt & Beglar 2002).

While it has been shown that *intentional learning* (see below) is far more effective in terms of quantifiable learning outcomes, it has been noted that "there are more words to know than can be readily treated in instructional activities during the timeframe of a typical language course" (Horst 2005: 356). Hence, the observation that advanced SLLs tend to enlarge their range of vocabulary predominantly through vocabulary learning strategies that facilitate incidental learning such as extensive reading, the reasons why being clearly discernible from the discussion above of the human memory system and its functioning. It must be noted however, that the learning that occurs here is particularly fragile and in need of immediate reinforcement (Nation 2013: 349), To briefly conclude, incidental learning has been shown to be less effective than explicit learning, though its contribution overall cannot be underestimated or indeed replaced by explicit learning (Hulstijn, Hollander & Greidanus 1996: 337).

In contrast, intentional vocabulary learning refers to the planned, explicit, and thus intentional targeting of vocabulary during the learning process. Intentional learning includes specifically designed vocabulary learning exercises such as flashcards, drills, and lists (Laufer 2005). It has been suggested that intentional vocabulary learning accounts for the majority of beginner EFL SLLs' vocabulary knowledge (Nation 2013; Laufer & Yano 2001). Reasons for this are varied, however, it is certainly the case that unfamiliar words present a formidable challenge to the learner, being as they are, strings of sounds that as yet have no semantic/conceptual meaning assigned to a corresponding mental representation, therefore a learner is initially unable to engage such inferential processes linked to background knowledge or other consolidated characteristics in LTM. Thus, Schmitt notes that intentional vocabulary learning "always leads to greater and faster gains, with a better chance of retention and of reaching productive level of mastery" (2008: 341).

With regards to intentional learning, a focus on explicit learning of vocabulary has been shown to result in the most effective learning gains in terms of vocabulary acquisition (Schmitt 2008: 329), and to consistently result in better learning outcomes in terms of words learned, the speed in which they are learned, and corresponding retention rates (Schmitt 2008: 341; Hulstijn & Laufer 2001). Many more empirical studies have confirmed the effectiveness of a deliberate targeting of vocabulary during instruction (Laufer 2005; Smith 2004; Lee 2003; Hulstijn 2003; Mehrpour 2008; Qian 1996), which can be understood here as being representative of support for any targeted vocabulary learning intervention that could be shown to increase learning outcomes such as the use of MALL vocabulary learning applications in EFL programs.

Taking a more teacher-centred perspective in the delineation of best practice in the teaching of vocabulary, Hunt and Beglar (2002) detailed three different approaches to vocabulary learning and teaching, loosely based on Nation's initial categorisation; *incidental learning*, *explicit instruction*, and *independent strategy development*. The authors also suggested that teachers should take time to carefully plan their vocabulary teaching in order to take advantage of all three of these different approaches in the offering of a wide range of exercises and activities for their students (Hunt & Belgar 2002).

In general however, it has been suggested that a systematic and planned approach to teaching vocabulary in the classroom should be taken, as the reliance on incidental learning alone is, in effect, quite limited due to the fact that in order to learn incidentally, a learner needs to possess a fairly large vocabulary to enable them to infer meaning in the first place (Nation 2002), however, there simply isn't enough time during most EFL programs for teachers to intentionally target the full range of vocabulary knowledge necessary for EFL learners to achieve the necessary range of vocabulary knowledge suggested above (see section 3.2. above), or level of language competence. Teachers should, therefore, seek to employ a wide range of activities, targeting both *incidental* and *intentional vocabulary learning*, and strategies such as inferring and guessing from context, integrating new words with old words, providing ample opportunities for encounters with newly learned words, semantic mapping, self-reflection, and dictionary training should be employed in order to achieve the best possible results (Nation & Meara 2002, 2010; Nation 2013; Schmitt & McCarthy 1997).

3.7.2. Taxonomies for vocabulary learning

A number of authors have proposed taxonomies of vocabulary learning strategies that categorise strategies into types in order to give teachers and learners a better overview of the options available when tackling vocabulary acquisition. Studies have shown that actively teaching *language learning strategies* which language learners can employ to help them overcome the pitfalls of learning a new language, significantly impacts learning outcomes (Oxford 1990a; Segler, Pain & Sorace 2002). An early attempt to categorise language learning strategies was made by Oxford (1990a). She categorised language learning strategies into two main types namely, *direct*, and *indirect* (Oxford 1990b), further separating each of these two categories into 3 sub-categories, with direct language learning strategies constituting memory, cognitive, and compensation strategies, and indirect language learning strategies constituting metacognitive, social, and affective strategies, finally settling on four broad categories, namely *social, memory, cognitive,* and *metacognitive* (Oxford 1990a). It has been shown that successful learners utilise an assortment of language learning strategies in their language learning (Lawson & Hogben 1996: 131). Thus, it can be extrapolated from this that the employment of a range of vocabulary learning strategies would similarly be of great benefit and most likely result in deeper levels of cognitive elaboration of vocabulary items in LTM.

As a subset of language learning strategies, vocabulary learning strategies constitute a wide range of language learning tasks that can include anything from focused vocabulary learning tasks to speaking and reading tasks (Segler, Pain & Sorace 2002). Though Oxford's taxonomy for language learning strategies is not wholly applicable to the learning of the entirety of the language system, it can be seen that the larger part of her taxonomy is applicable to vocabulary learning strategies, perhaps underlining the importance of learning vocabulary for the language system (Segler, Pain & Sorace 2002: 409).

Adopting parts of Oxford's taxonomy (Oxford 1990a) and later proposals put forward by Nation (1990), Schmitt (1997) attempted a complete inventory of possible vocabulary learning strategies, proposing his own taxonomy that settled on two dimensions along which he classified a total of 58 strategies. Borrowing Oxford's first classification dimension of the identification of 4 main categories of strategy, Schmitt added a 5th category which he named *determination*, in an attempt to capture those strategies that involve the individual learner's intelligent guesses without the help of external prompting. This led to a classification of vocabulary learning strategies into the categories *determination* (DET), *social* (SOC), *memory* (MEM), *cognitive* (COG), and *meta-cognitive* (MET) (Schmitt 1997). As a second dimension,

Schmitt then adopted a distinction originally made by Nation (1990), recognising the difference between strategies for the identification of meaning, and strategies which focus on how to ensure that meaning enters and remains in memory. The two dimensions, namely *discovery* (DISCOV) and *consolidation* (CONS) are distinguished from each other in that discovery strategies refer to the primary act of discovering the meaning of a new word, while consolidation strategies are strategies for remembering the discovered meaning (Schmitt 1997).

Table 1 below, contains a reproduction of Schmitt's taxonomy to illustrate the overall organisation around the two concepts of discovery and consolidation;

Table 1: Schmitt's Taxonomy: Categorisation of vocabulary learning strategies (Schmitt 1997)

Concept	Strategy Types	Explanation	Vocabulary Learning Strategies
Discovery (DISCOV): discovering the meaning of unknown words	Determination Strategies (DET)	Finding meaning without recourse to others	Analyse part of speech
			Analyse affixes and roots
			Check for L1 cognate
			Analyse available pictures or gestures
			Guess meaning from context
			Bilingual dictionary
			Monolingual dictionary
			Word lists
			Flash cards
	Social Strategies (SOC)	Consulting or working with others to discover	Ask teacher for L1 translation
			Ask teacher for paraphrase or synonym
			Ask teacher for sentence including item
			Ask classmates for meaning
			Discover new meaning through group
Consolidation (CONS): remembering words once their meaning has been discovered	Social Strategies (SOC)	Consulting with others to consolidate	Study and practice meaning in a group
			Teacher checks students' flash cards or word lists for accuracy
			Interact with native speakers
	Memory Strategies	Mnemonics	Study word with a pictorial representation
			Imagine a word's meaning
			Connect word to a personal experience
			Associate word with its coordinates
			Connect word with its coordinates
			Connect word to its synonyms and

			Use semantic maps
			Use 'scales' for gradable adjectives
			Peg Method
			Loci Method
			Group words together to study them
			Group words together spatially on a page
			Group words together with a storyline
			Use new words in sentences
			Study the spelling of a word
			Study the sound of a word
			Say new word aloud when studying
			Imagine word form
			Underline initial letter of the word
			Configuration
			Use the keyword method
			Affixes and roots (remembering)
			Part of speech (remembering)
			Paraphrase the word's meaning
			Use cognates in study
			Learn the words of an idiom together
			Use physical action when learning a word
			Use semantic feature grids
	Cognitive Strategies		Verbal repetition
			Written repetition
			Word lists
			Flash cards
			Take notes in class
			Use the vocabulary section in your textbook
			Listen to tape of word lists
			Put English labels on physical objects
			Keep a vocabulary notebook
	Metacognitive Strategies	Planning, monitoring, evaluation of learning	Use English-language media
			Use spaced word practice
			Test yourself with word tests
			Skip or pass new word
			Continue to study the target word over time

Without going into detail concerning each specific vocabulary learning strategies mentioned here by Schmitt, one major observation which can be quite clearly made from the taxonomy itself is that if a language learner is to employ an adequate range of strategies, the act of vocabulary learning is unquestionably a time-consuming endeavour (Schmitt 2000: 6). Thus, any method that could either reduce the amount of time needed to learn, or alternatively, make the time spent on learning vocabulary more efficient or even simply more palatable to the learner to increase their motivation, would undoubtedly be of advantage in any EFL teaching program to counteract any loss of motivation that may ensue in language learners due to the sheer size and energy requirement of the task. A further consideration that concerns the suggested vocabulary learning strategies themselves is the question of learning context. Naturally, some of Schmitt's vocabulary learning strategies will lend themselves more to one learning context than to the other and this will affect the choice of vocabulary learning strategies by the learner, or the choice of recommendation by the teacher (Schmitt & McCarthy 1997). When learning context is taken into account, factors such as the proficiency of the language learners, the language learners' L1, language learners' motivation, and the simple nature of the language learning task itself all come into play (Schmitt 2000: 116).

In a rather less specific and simplified taxonomy, Nation (2013) organised vocabulary learning strategies into three classes of strategies, namely; *planning*, *sources*, and *processes* (Nation 2013). The taxonomy is reproduced in table-form below (see table 2), though is clearly far less detailed than Schmitt's, and fails therefore to specify individual vocabulary learning strategies. Nation does however, tellingly base his categorisation along the same continuum of knowledge as that exemplified in the construct of *vocabulary knowledge* discussed above (see section 3.3. above);

Table 2: Nation's Taxonomy: Categorisation of vocabulary learning strategies (Nation 2013)

General class of strategies	Types of vocabulary learning strategies
Planning: choosing what to focus on and when to focus on it	Choosing words to focus on
	Choosing aspects of word knowledge
	Choosing appropriate strategies
	Planning repetition (increasingly spaced)
Sources: finding information about the words	Analysing the word parts
	Using the context
	Consulting a reference source in L1 or L2
	Using similarities or differences in L1 and L2

Processes: establishing knowledge	Noticing
	Retrieving
	Generating

As is clear to see, and in consideration of the previous discussion concerning the construct of *vocabulary knowledge* (see section 3.3. above), Nation organises his categories around the continuum of form, meaning, and use (Nation 2013). Following a process of planning, in which vocabulary, its aspects, and strategies are selected, Nation's second class of sources seeks to take the learner's knowledge of vocabulary items beyond that of simple form, and consolidate progressively deeper aspects of items' meaning by strengthening connections with the learner's existent semantic network, and forging links with linguistic material already in LTM. Nation's three cognitive processes of *noticing, retrieving*, and *generating* (see section 3.5. above) are then brought into play, providing the necessary rehearsal and repeated encounters with the vocabulary items that enable the elaboration required for successively deeper analyses in LTM that will subsequently lead to mastery of the item (Nation 2013).

3.7.3. Applying vocabulary learning taxonomies to MALL

As a cautious attempt to integrate the insights that have arisen from the above discussion into a relevant conclusion in relation to MALL vocabulary learning implementations, it seems that what we are dealing with in terms of the utilisation of mobile technologies in the learning of EFL vocabulary and their relation to vocabulary learning strategies with relation to Schmitt's taxonomy is the very real opportunity of combining many and varied vocabulary learning strategies in an easily accessed format that will allow multiple and varied encoding and LTM consolidation of newly learned vocabulary items that would ideally be reinforced by optimally spaced encounters and rehearsals and the provision of multiple opportunities for generative use within a truly mobile pedagogical paradigm. If a given MALL application is to be maximally effective therefore, it needs to provide the learner with initial DISCOV strategies for the discovery of new meanings through perhaps reading text on screen, observing related pictures, or listening to audio recordings of the said word/phrase, and, following this, provide effective CONS strategies in order to cement the discovered meaning in LTM for fast, efficient, and successful recall. CONS strategies could include initial encoding strategies that enhance the learner's memory; however, they could also include strategies which focus on reviewing knowledge that has been inadequately memorised.

In terms of the advantages that the use of MALL applications can bring, it can be seen that certain functionalities offered by mobile technologies, when understood in terms of recognised taxonomies such as Schmitt's, could prove to be particularly advantageous. The ability to offer the learner a wide range of DISCOV strategies in terms of presentation modes ranging from audio and video, to hypertext and glosses, can allow multiple opportunities for learners to find their own perfect strategy, and follow that up with CONS strategies that can quickly and efficiently encode and review newly learned items. All this could be supplied in an instantly accessible and truly mobile package allowing, in terms of vocabulary learning at least, a truly *anytime* and *anywhere* paradigm.

It can be seen here that Schmitt's taxonomy is certainly relevant to a MALL vocabulary learning paradigm. In how far it is a complete picture of what is a relatively new learning paradigm in MALL and could open up new possibilities in the ways in which SLLs access vocabulary learning material in their learning activities is still up for debate. However, it has been shown that the taxonomy is extensive and has been described by researchers as being amongst the most thorough of the various taxonomies that have been suggested in the literature (Segler, Pain & Sorace 2002).

3.8. Vocabulary learning methods – flashcards

Regarding intentional vocabulary learning methods, word lists and flashcards or word card methods dominate the literature, having been endorsed by many language teaching methodology researchers (Nation 2013; Laufer & Yano 2001; Editorial 2005). A popular learning strategy for vocabulary acquisition, researchers have suggested that "perhaps no memorization technique is more widely used than flashcards" (Kornell & Bjork 2008: 125). Flashcards, or equivalent concepts of delivery, have readily lent themselves to the jumping of the digital divide, and digital flashcard applications and online digital materials in various related forms are now commonplace in the learning industry (Golding, Wasarhaley & Fletcher 2012: 199). As this study will focus on just such an application, a short discussion of selected findings in the literature will aid later study design.

Tying these observations with the discussion on memory and cognition above (see section 3.4. above), it has been noted that flashcards allow learners to leverage the effects of repetition and rehearsal and practice the process of active recall quickly and easily (Sage et al. 2016: 431). The use of flashcards has thus been shown to increase the verbal abilities of language learners

with relation to their reading ability and vocabulary size (Kupzuk, Daly & Anderson 2011). Additionally, performance on exams has been shown to significantly increase when university students utilise them in exam preparation (Golding, Wasarhaley & Fletcher 2012).

In terms of studies looking specifically at digital flashcards and their relation to and comparison with paper-based versions and methods, Davis (2013) investigated the efficacy of digital flashcards on university students' exam preparation. Significant points of interest from this study included students' perceptions of the convenience offered by having easily accessible digital flashcards that could be carried around and accessed *anytime* and *anywhere*, and the feeling that the flashcards had helped motivate the students to learn. Additionally, students reported spending more time studying course content. Interestingly however, Davis reported that no significant improvements in exam scores were shown by the experimental groups in the study, and, made the observation that on a small number of exams during one semester, students performed significantly worse than in previous semesters. The author concluded that students were neither helped nor hindered by the use of the flashcard application, and that it was most probable that the use of digital flashcards was better than a lack of a studying tool (Davis 2013).

With respect to further digital and paper-based comparative studies Sage et al. (2016) reported that digital and paper flashcards were equally effective. Providing significantly positive results that support the efficacy of flashcard use are studies previously mentioned above that report significantly positive results for the use of MALL vocabulary learning flashcard applications such as that of Basoglu and Akdemir (2010) who reported significant vocabulary gains for students utilising a vocabulary learning mobile flashcard application in comparison to paper-based methods, reasoning that the convenience and portability of the mobile application was responsible for the study's significant results.

In summary, the findings reported in the literature on the efficacy of flashcard use whether digital or paper-based are generally quite mixed and certainly require further research, though the general concept of flashcard use for the purposes of memorisation of information marries well with research on memory, depth of processing, and subsequent memory recall.

3.9. Summary

In summary, the following important points can be gained from the discussion above. To know an item of vocabulary, and thus to acquire it, means much more than to simply possess formal knowledge of the item. Mastering an item of vocabulary involves many different skills which allow the language user to utilise the item over a wide range of different linguistic contexts (Thornbury 2002; Burgess & Lund 1997). Important for the acquisition process is the distinction between the three characteristics of *form*, *meaning*, and *use* (Nation 2013) which represent a continuum along which the vocabulary knowledge of the language learner progresses as they gradually come to master a vocabulary item. It appears that it is a common consensus that the process of VA is an incremental process that takes place along a continuum of depth, from form, through to use, and is epitomised by increasingly deeper levels of cognitive analysis during the formation of successively stronger and more complex mental representations which give rise to successful use across a wide range of contexts and ultimately, to vocabulary mastery (Nation 2013). This in turn ties in with findings from cognitive psychology that are underpinned by the Depth of Processing Hypothesis (Craik & Lockhart 1972; Lockhart & Craik 1990), which states that it is the depth of cognitive analysis to which a stimulus is subjected upon encoding with regards *semantic involvement*, that directly effects LTM retention rates (Segler, Pain & Sorace 2002; Lockhart & Craik 1990).

Remaining with the depth dimension of semantic involvement, it appears that before a language learner is able to successfully use an item of vocabulary, they are able to recognise its form and its meaning. This implies the existence of a receptive/productive dimension to VA that exerts its influence as the item of vocabulary progresses along the depth continuum (Henriksen 1999). It has been suggested that a language learner proceeds along this continuum of vocabulary knowledge towards eventual mastery of an item, and that this progression involves four stages or steps, from familiarisation with the item's form, through to developing appropriate semantic and conceptual representations in memory and finally achieving the consolidation of those representations with existing knowledge of the world (Deane et al. 2014). It is generally held therefore, that although it may be more difficult and require greater cognitive effort on the part of the learner, active, or productive learning in which vocabulary items receive explicit focus during the acquisition process, leads to a deeper level of processing and, therefore, to stronger and longer-lasting learning effects (Hunt & Belgar 2002; Schmitt 2008).

It has been suggested that the *mental lexicon* itself, in which any novel item of vocabulary, if it is to be mastered must eventually embed itself, is a complex web of meanings, organised in

semantic clusters (or lexical sets) that allows cross referencing across multiple different characteristics such as semantic fields and phonetics (Hedge 2000). In order to achieve progressively deeper levels of analysis during the process of acquiring an item of vocabulary and consolidating its semantic and conceptual representations in LTM, a number of factors have been shown to exert their influence. Working memory, and as highlighted above, Baddeley's concept of M-WM, plays a pivotal role in the consolidation of novel language in LTM. It is here that we see that the spaced repetition of vocabulary items highlighted above in the MALL literature review is able to exert its influence (see section 2.7. above). The M-WM is of limited capacity, and its functioning is determined by the interplay between the natural decay of short-term representations and the limits of the mechanism responsible for rehearsal (Baddeley 2010). Part of this rehearsal mechanism, the phonological loop, is responsible for the storage of unfamiliar patterns of sound during which the episodic buffer constructs deeper and more permanent representations in LTM. The entire process under question here ultimately requires the attention of the language learner, and it is here that the concepts of noticing, retrieval and generative use play their part (Nation 2013).

Once engaged with a novel vocabulary item, encoding processes are affected by repeated exposure, which is the reason why the notions of rehearsal and repetition (in particular the spaced repetition of vocabulary items), are repeatedly highlighted in the literature as being preferable (Nation 2013: 452) and have been shown to lead to significant learning outcomes (see section 3.5. above). Estimates as to the number of repetitions that are necessary vary, however, it can be seen that the more repetitions a language learner experiences, the deeper the resulting analysis and the stronger the eventual encoding in LTM (Randall 2007). Although researchers also disagree on the exact spacing between repetitions, due to the limited capacity of M-WM it has been suggested that repetitions need to occur fairly rapidly after the first engagement with a novel item of language, and that periods of time between repetitions thereafter become successively longer before the natural processes of information decay cause forgetting to occur (Schmitt 2008).

Deeper processing of the meaning of vocabulary in terms of the number and strength of the connections within the mental lexicon that are forged during repeated exposure to an item enhance the likelihood of future recall and successful use. Indeed, Schmitt and McCarthy (1997: 3) succinctly include a connection with the Depth of Processing Hypothesis in their following description of this phenomenon;

> The more cognitive energy a person expends when manipulating and thinking about a word, the more likely it is that they will be able to recall and use it later. […] The implications extend to pedagogy, suggesting that exercises and learning strategies which involve a deeper engagement with words should lead to higher retention than 'shallower' activities. (Schmitt & McCarthy 1997:3)

From this it can be seen that wide and varied presentation modes of vocabulary items will lead to progressively deeper analysis (Arias 2003). Here, vocabulary learning strategies, or the deliberate targeting of vocabulary items with differing methods, play their part, and it is evident that the higher the variety and wider the breadth of associations that can be drawn in the material presented, the deeper the analysis in LTM will be (Arias 2003; Oberg 2011; Oberg & Daniels 2013).

In conclusion, the stronger, more varied, and greater the number of connections between an item of vocabulary and its eventual embodiment within the mental lexicon, the easier and quicker eventual recall from LTM will be (Schrauf & Rubin 2000; Schrauf 2003) and thus the more successful the resulting use of the vocabulary. Thus the efficiency of the process of recalling items from LTM is directly related to the quality and variety of the encoding process itself, from initial engagement with a novel item of vocabulary, through each successive elaboration and deeper level of analysis of the item as it proceeds along the continuum of successively embedding itself within the mental lexicon and forming lasting, and successively strengthening connections with the linguistic and semantic world of the language learner (Baddeley 2010). This entire process ultimately leads to successful language use across a wide range of contexts (Nation 2013).

4. Methodology

As established in the above discussion, currently, MALL studies that have investigated the effects of mobile technology use on the teaching and learning of vocabulary claim mainly positive results, however, these results should be approached with a measure of caution and remain inconclusive (Lin & Lin 2019: 1; Burston 2015). It has also been noted that there has been relatively little research conducted on readily available MALL software applications (Abarghoui & Taki 2018: 1760). Additionally, attention has frequently been drawn to the importance of establishing firm, pedagogically founded theories concerning the efficacy of MALL implementations and supporting these with statistically reliable data, which has unfortunately been distinctly lacking in much of the MALL research published to-date (Burston 2015). The importance of such research on the efficacy of MALL vocabulary learning applications and their comparison with traditional paper-based methods in our current age of technology has also been noted by researchers (Sage, Krebs & Grove 2019: 464).

The present research paper will, therefore, attempt to address the points mentioned above and attempt to replicate findings of previous research that has compared various MALL implementations with traditional, offline paper-based learning methods, with a comparative study on the effects of a readily available and free MALL software application named Memrise (Memrise.com) on vocabulary learning outcomes in a school-level EFL classroom context. The study will additionally supplement empirical results with qualitative data collected by means of an online post-test questionnaire in order to gain better understanding of the pedagogical issues involved in MALL implementation in an EFL context and the attitudes of EFL learners to the implementation of such MALL vocabulary learning applications in their language courses.

As has been highlighted in the discussion above, MALL vocabulary learning applications have been shown to successfully leverage differing factors that affect the process of VA which have often produced significant and positive learning outcomes (Chen & Chung 2008; Azabdaftari & Mozaheb 2012). From the discussion of the functioning of cognition and memory in the process of SLA above, it can be seen that the Depth of Processing Hypothesis (Craik & Lockhart 1972; Lockhart & Craik 1990) plays a pivotal role in the consolidation of semantic and conceptual information pertaining to vocabulary items in LTM, which in turn, results in the successively deeper levels of analysis that are essential for successful long-term recall and vocabulary item mastery (Nation 2013). Additionally, the discussion above revealed the significance of optimally spacing repetitions and the positive effect this has been shown to have

on the process of strong memory consolidation in LTM (Chen & Chung 2008; Azabdaftari & Mozaheb 2012). By providing a MALL application that allows the leveraging of the Depth of Processing Hypothesis and couples this with a system that attempts to optimally space repetition and rehearsal of vocabulary items, as Memrise does, effects on learning outcomes may be measured against a control group utilising only offline paper-based learning materials, and results of previous studies mentioned above tested.

Additionally, the multi-modal functionality of Memrise, offering as it does, audio and image functionality that enables its users to upload additional material related to each individual vocabulary item, will allow a multi-modal presentation of vocabulary items that will test the conclusions of studies such as Baleghizadeh and Oladrostam (2010) and leverage Mayers' cognitive theory of multimedia learning (Mayer 2001).

4.1. Research questions and hypotheses

The following 3 research questions will be addressed in this study, along with relevant sub-questions;

1. What is the effect in terms of learning outcomes when using a MALL vocabulary learning application, on the L2 English vocabulary knowledge of EFL learners in comparison to using offline, paper-based learning methods?
2. What were the individual perceptions and learning experiences of participants?
   a. Where, when, and for how long did participants, in both the experimental and the control groups, engage with the learning materials?
   b. What did participants like/find useful/dislike about using the MALL application?
   c. What would participants change about the application?
3. What are the attitudes and perceptions of participants concerning MALL vocabulary learning interventions in the EFL classroom and would they support future integration?

From the findings arising from sections 2 and 3 it can be hypothesised that with relation to the first research question, significantly positive learning outcomes would be expected in the experimental group with relation to the control group on measures of medium-term and *delayed post-test* (DPT) vocabulary retention rates in keeping with results obtained in studies discussed above that have compared MALL vocabulary learning applications to traditional, offline, paper-based methods (Chen & Chung 2008; Azabdaftari & Mozaheb 2012). However, it must

also be noted here that other studies have contradicted these findings, finding no difference between experimental and control groups (Davis 2013).

In terms of the second research question it can be expected that the *anytime, anywhere* learning paradigm that is enabled through the use of a MALL implementation may result in differing learning behaviour between the groups, with the experimental group spending more time engaging with the materials during times in which they would not normally be afforded the opportunity to learn (so-called *dead time*). However, there are studies have shown differing results, with Nikoopour and Kazemi for instance, reporting no significant differences between groups when comparing equally portable and accessible learning materials (Nikoopour & Kazemi 2014), therefore, this may well not prove to be the case.

With regards the third research question, it could be expected that due to increased motivation as a result of the gameification aspects Memrise (see section 4.2. below), coupled with a perceivable increase in learning outcomes brought about by the optimisation of item rehearsal, participants will have positive regard for the implementation of MALL vocabulary learning applications in their EFL course and will therefore be supportive of curricular integration.

4.2. Memrise

Specialising in foreign language acquisition, Memrise is predominantly a language learning application for use on smartphones and tablets, as well as desktop computers via its web-based browser application. The application focuses on developing LTM connections by utilising the *spaced repetition* of interactive flashcards in a number of different exercise-formats to teach the meaning of single words and phrases in order to maximise the rate and success of learning (Memrise.com).

Designed and built by experts in psychology and specifically the psychology of memory (Abarghoui & Taki 2018), the app uses an internal algorithm to determine the rate and frequency at which learners need to visit and revisit vocabulary items to maximise the probability of strong encoding in LTM. Memrise focuses on giving users a *gamified* experience in order to increase motivation to learn, using the metaphorical concept of a flower that must be planted and watered to represent first encountering a vocabulary item, and then continually strengthening and growing knowledge of that item with repetitions that are progressively spaced over longer and longer periods of time until finally the flower opens, representing the embedding of knowledge in LTM.

Learners are able to make use of multiple-choice exercises, typed translations, and optional images and audio uploads to cement, strengthen and finally test their vocabulary knowledge. This is done through three separate language learning modules named *learn new words*, *classic review*, and *speed review*, in which vocabulary items are first implanted in memory before being strengthened through repetition with optimally spaced reviews and finally tested in either untimed, or quick-fire rounds of tests. The app focuses on using a range of different presentation methods in order to maximise the user's ability to achieve consolidation and transfer of meaning in LTM, hence its suitability for use in a comparative study such as this as these extra features markedly set the application apart from traditional paper-based list-learning methods and support findings from previously discussed studies on multi-modal presentation of vocabulary items and resulting effects on LTM consolidation (Baleghizadeh & Oladrostam 2010; Lin & Yu 2012, 2017; Agca and Özdemir 2013; Wu 2014; Shimoyama & Kimura 2009).

In addition, Memrise offers free access to the application and online platform with adequate functionality for the carrying out of the present research study, making it an ideal choice, not only for the current investigation, but also for use in general by EFL practitioners who are looking for a MALL solution in which they have the ability to create tailored, course-specific learning materials to complement classroom teaching.

4.3. Context

The present study was conducted at an Austrian public high school (AHS Gymnasium) which is a member of the *Vienna Bilingual Schooling System* (VBS) (Vienna Bilingual Schooling 2019). The VBS is a long-running language-focused program that is currently offered in 10 high schools in Vienna, Austria (Vienna Family Network 2019). The program provides "bilingual education in English and German from elementary school to lower secondary school through to matriculation" (Vienna Bilingual Schooling 2019). Based on the Austrian curriculum, skills in both languages are taught by both English and German-speaking language teachers in equal measures of the two languages, over a range of different subjects across the curriculum. The program attracts a wide demographic, ranging from children with bilingual and monolingual English-speaking backgrounds, to bilingual backgrounds in which neither English nor German are spoken, to monolingual German speaking backgrounds, (exact statistics are however, unfortunately unavailable). Previous knowledge of English and German is required in order to gain entry into the VBS program, and pupils are required to pass a

preliminary English exam upon entry into the program in the 1st year of Gymnasium (approx. 10 years of age).

4.4. Participants

Participants in the study were 44 pupils between the ages of 15 and 17 attending the upper forms of the VBS. The study took place in two English classes in the upper forms, namely the 10th and 11th grades, with 44 participants exhibiting a *common European frame of reference for languages* (CEFR) level of between approximately B1 (Council of Europe 2001).

All participants had personal, private access to mobile smartphone devices running operating systems compatible with the vocabulary learning application to be tested. All participants were asked to give written consent prior to participation in the study and all personal data collected was kept strictly anonymous through the assignment of a unique identification number which was used throughout the study to identify and refer to individual results.

Regular timetabled English lessons of 50 minute teaching blocks took place with the regular English teachers for three blocks per week throughout the duration of the study in both classes, during which target vocabulary items utilised in the study were also taught within the context of each teaching unit in the classes' course books.

4.5. Procedure

To adequately address the three research questions, a mixed-method research design was employed involving the collection of quantitative data on learning outcomes, and a mixture of both quantitative and qualitative data on participant learning behaviour, attitudes, and perceptions. Quantitative data was collected by means of short vocabulary retention tests administered weekly over the duration of the 4-week experimental period, while qualitative data was collected through an online questionnaire administered at the end of the 4-week period. A mixed method design was chosen due to the nature of the research questions, each requiring different methods of data collection and analysis, and in order to address the individual drawbacks of both quantitative and qualitative data-collection methods.

A comparative experimental design was used to compare the use of mobile devices in the learning of EFL vocabulary with that of learning vocabulary with analogous paper-based methods. The independent variable for the experiment was thus *method of vocabulary learning*, being either *MALL application* or *paper-based methods*. The corresponding dependent variable was the *measure of learning outcomes* which was measured by short vocabulary retention tests

administered at two separate time intervals to test both medium-term and delayed memory of vocabulary items.

Prior to beginning the study, participants' respective English language levels were determined through the collection of existing assessment data. This was done in order to eliminate effects of language competence from the results, a missing step in many MALL studies that has been addressed in the above discussion. At the point at which the study began, individual scores on previous vocabulary tests and one major English exam had already been assessed by the classes' English teachers and these scores were combined with teachers' personal assessments of each participant to give a score between 1 and 5 (1 = very good, 5 = very poor), which provided an overall picture of general language level and allowed controlled allocation into control group and experimental group conditions. Participants were assigned to one of two groups on the basis of these scores, an experimental group and a control group, n=22, and n=22 respectively, so that average language levels for the two groups were approximately equal (Experimental Group = 2.20 and Control Group = 2.23) (see Appendix below).

Participants were briefed on the purpose, expectations, and duration of the proposed interventions prior to beginning the study. Participants in the experimental group were given instructions on how to download and install the Memrise vocabulary learning application on their smartphones (see section 4.2. above). A short tutorial was given, showing participants in the experimental group the functionality of Memrise and its accompanying online website, how to set up an account and how to access and use learning materials. A similar tutorial was also given to the control group, containing all relevant information, including how to access learning materials and details about the study. Participants in both groups were instructed only to use the respective learning method for their particular group, for the experimental group this was of course Memrise, while the control group were instructed to use only their course books, and/or any other form of paper media normally used when completing such vocabulary learning exercises such as self-made paper-based flashcards or handwritten lists. Links to previously prepared vocabulary courses were shared with all participants via a regular English class course page on a local installation of Moodle, which was used throughout the study to share all following links to weekly target vocabulary item lists and to provide general information on the study such as the weekly performance of the two groups.

Each week during the first timetabled English lesson of the week in both English classes, a list of 25 vocabulary items from the relevant coursebook chapters to be taught that week was set

as a vocabulary learning task for testing the following week. Target vocabulary items were selected from the classes' regular English coursebooks; "Prime Time 6" (Hellmayr et al. 2010) and "Prime Time 7" (Hellmayr et al. 2009), except during week 3 in the 11th grade (7A) as the class teacher requested that vocabulary from an alternative book be used to tie in with that week's teaching material (McCarthy & O'Dell 2017: 90-92).

There were a number of reasons for taking vocabulary items directly from the classes' standard English coursebooks and other regular teaching materials. Firstly, in order to provide as authentic a context as possible for the study, enabling more solid arguments for or against the inclusion of MALL implementations into EFL curriculum-based courses to be made. Secondly, to enable the vocabulary items learned for the study to be of use to the participants, therefore avoiding as much as possible the issue of participant motivation, as the vocabulary recall tests helped towards the participants' overall learning goals and were not seen as an extra unnecessary learning burden.

After individual learning-phases each lasting for a period of 1-week during which participants learned the weekly vocabulary item lists (see Appendix below) using their respective methods, participants were tested on their *medium-term memory* (MTM) with short, 10-question vocabulary tests. Test items were designed to be answerable only with deeper understanding of the meaning of vocabulary items, thus, questions were modelled after Deane et al. (2014) vocabulary item types, utilising wherever possible idiomatic associations, topical associations synonyms and hypernyms in order to activate deeper neural connections in LTM involved in the recall of more elaborately consolidated mental representations (Deane et al. 2014).

Following four MTM weekly vocabulary tests of this nature, participants completed a final DPT vocabulary recall test consisting of vocabulary items from the first 3 weeks' vocabulary lists. This DPT test was identical in every respect to the previous MTM tests in format and test type and consisted of 6 vocabulary items from each of the 3 previous weeks' target vocabulary item lists, 3 items that had already been tested in the MTM tests and 3 items which had not previously been tested. This gave a total of 18 vocabulary items on the DPT test.

Following completion of the comparative experiment, an online participant questionnaire was administered using Google Forms (https://www.google.com/forms/about/) in order to address research questions 2 and 3 and their related sub-questions. Results of the questionnaire were kept anonymous by using the same Unique-ID number system utilised throughout the study. Questions included items on preferences, attitudes, and opinions of respondents, along with

more specific factual questions about learning behaviours of the participants (see Appendix below).

Participation in the questionnaire was voluntary and participants answered a combination of nominal polytomous questions (in which respondents were given a list of unordered options), bounded-continuous questions, in which respondents were presented with 5-point Likert scales (with 1 indicating the highest/strongest/most agree/most satisfied, and 5 indicating the lowest score/weakest/disagree/most dissatisfied) with appropriately labelled responses ranging between two extremes, in cases where a scale of feeling or opinion was required, and semi-structured questions in which participants could give short, individual answers.

The questionnaire was organised in two sections, a section of questions which were identical for both control and experimental groups, consisting of questions on learning behaviour, and a second section of questions that were specific to the experimental group, consisting of questions specific to the use of Memrise. Based upon previous findings in the above literature review (see section 2 above) a number of expectations concerning respondents' attitudes and learning behaviour were hypothesised. Due to the overwhelmingly positive attitudes towards MALL implementations reported in the literature (Tan & Liu 2004; Lin & Lin 2019:; Burston 2015; Al-Emran, Elsherif & Shaalan 2015; Al-Said 2015; Deris & Shukor 2019; Basal et al. 2016; Cavus & Ibrahim 2009; Soleimani, Ismail & Mustaffa 2014; Kim et al. 2013), it was expected that respondents to the questionnaire would also display the same enthusiasm for MALL implementations in their day-to-day EFL language course and also a similar enthusiasm for the use of the Memrise application. In addition, based upon researchers' continued citing of the ubiquitous and *anytime, anywhere* accessibility of learning materials afforded by MALL applications and the supposed positive effect on learning outcomes that has been proposed as a result of the changes that such a paradigm brings about on learning behaviour (Wu 2014, 2015; Agca and Özdemir 2013; Nikoopour & Kazemi 2014), it was expected that there would be a marked difference between the learning behaviour exhibited by the experimental group in comparison with the control group, and questions were designed to reveal and highlight this difference for later analysis.

In as far as was possible, questions on the questionnaire were ordered in a manner that placed the factual and behavioural questions first, and the attitudinal/opinion questions last in order to give the participants the feeling of a general flow from less personal/sensitive, to more personal/sensitive, and from general to more specific. Full details of all raw data collected

during the study and details of the participant questionnaire can be found in the Appendix section below.

5. Results and data analysis

Complete details of the quantitative and qualitative data collected for this study are contained in the Appendix section below.

5.1. Correlation between pre-test ranking and average scores

Calculations of Pearson's correlation coefficient were performed on pre-test ranking marks and the average scores obtained on MTM tests to ascertain whether pre-test ranking of English ability was predictive of subsequent performance and thus justified original participant ranking within the two groups. These calculations were carried out in order to determine the extent to which memory tests were measuring prior ability. Three correlation coefficients were obtained, the first relating to datasets including all participants, the second and third relating to the datasets of each of the two groups.

A calculation of correlation for all participants gave a weak negative correlation coefficient of -0.20426, showing that English ability as previously measured by the English classroom teachers, was only weakly correlated to subsequent performance on MTM tests. Interestingly however, individual correlation coefficients for the experimental group and the control group revealed a very weak -0.11305, and a significant negative correlation of -0.60742 respectively. These results could show something quite interesting concerning the effect of using the Memrise application on the experimental group and suggest that it may be possible that the using of a new method altogether was to an extent a disturbing factor for the experimental group.

There are of course different interpretations that may be made in the absence of further investigation. It could be the case that the particular method of learning vocabulary utilised by the control group continued to produce similar performance on subsequent testing, while the use of Memrise altered subsequent performance, indicating that a change in learning methods could actually suit different individuals whilst actually hindering others. It may also simply be the case that participants in the experimental group were simply not familiar with the new method of learning and needed time to adapt.

5.2. Vocabulary tests

Concerning the quantitative data collected from participants' scores on the vocabulary tests, results from MTM and DPT tests were analysed under three separate conditions as it became clear during the experiment that engagement with the materials by the participants in the experimental group varied considerably. Of course, levels of engagement with the paper-based materials in the control group remained unknown, however, through a built-in points system within Memrise it was possible to keep track of the experimental group participants' weekly engagement with the learning materials. Participants' engagement in the experimental group resulted in weekly point-scores which were recorded along with participant scores on the vocabulary tests. As can be seen from the results (see Appendix below), a small number of participants were observed to have engaged consistently with Memrise, whilst others displayed varying degrees of engagement, and others could be seen hardly to engage at all.

For this reason, the decision was taken to analyse results under three separate conditions to give a full picture of the results. Firstly, results were analysed without adjustment to check for significance. Secondly, results were adjusted for at least a minimum measure of participant engagement with the materials in order to exclude instances where it could be definitively stated that participants had not engaged with Memrise and therefore were most probably either guessing the answers on the tests, or had learned the vocabulary from another, invalid source. It should be noted here that poorly performing participants and participants who had only minimally engaged with the materials were also included in this condition of analysis. Finally, in the third condition of analysis, only the participants who could be shown to have engaged consistently with the materials throughout the experiment were included in the analysis in order eliminate any effects of general ability and to only include continually engaging participants for whom it could be definitively shown that they had indeed gained their knowledge of the target vocabulary through consistent engagement with Memrise. In each of the second and third conditions, equivalent numbers of the highest scoring individuals from the control group were included in each analysis in order to make it as likely as possible that selected participants from the experimental group were compared with approximately equal control-group participants who had also engaged with the learning materials. Although it is accepted here that there was no way of telling if this indeed was the case, it is suggested that had a different method of selection been exercised and participants from the control group chosen on some other grounds, then quite serious criticisms could have been levelled at the methods of analysis chosen here, above and beyond those that are already to be expected.

Means and standard deviations for each of the three conditions of data-analysis (*overall results, minimal Memrise engagement,* and *full Memrise engagement*), were calculated. *Two-sample t-tests* were performed on the average scores obtained by each participant calculated over the 4 MTM tests, and the scores obtained on the DPT test, in order to determine the statistical significance of mean scores. A significance level of $a = 0.05$ was used to determine the statistical significance of the results.

Variances in the number of participants in the overall results condition (see table 3 below) were due to unforeseeable absences of participants due to illness. In each case, numbers in the groups were evened out by discounting low scoring participants from the other group.

Tables 3 - 5 below show the mean scores (M) and standard deviations (SD) for each of the 4 MTM vocabulary tests and the overall averages calculated over the 4 tests, in addition to the mean scores and standard deviations obtained on the DPT test, for both the control and experimental groups, and for each of the three conditions of analysis;

Results of all three conditions of analysis are given below with further clarification of each condition.

5.2.1. Overall results

Initially, all quantitative results collected for both the MTM tests and the DPT test, were analysed without adjustment, in other words, regardless of any recorded engagement with the Memrise application (as measured in the application itself).

Table 3: Results for MTM and DPT vocabulary tests – *Overall Results*

	Medium-Term Memory										Delayed Post-Test	
	Week 1		Week 2		Week 3		Week 4		4-Week Average			
Number of Participants	n=44		n=41		n=39		n=40		n=44		n=40	
Mean/Standard Dv	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Control Group	6.84	2.58	7.11	2.24	7.71	2.65	4.93	2.11	6.65	1.79	9.05	3.66
Experimental Group	7.02	1.8	5.73	3.11	6.61	3.16	5.48	3.57	6.41	2.11	8.8	5.05

5.2.2. Adjusted for minimal Memrise engagement

Secondly, results were adjusted for minimal engagement with the application in the experimental group, with participants who recorded 0 points on the application for a particular week (indicating no engagement with the materials) being discounted, and remaining participants who had scored > 0 (indicating at least minimal engagement with the materials) were compared with an equivalent number of top-scoring participants in the control group so as always to give equal numbers of participants in each group for each week. For the DPT test results, under this condition, only participants who showed engagement with Memrise in all 3 weeks from which the vocabulary items for the DPT were included.

Table 4: Results for MTM and DPT Tests - *Adjusted for minimal Memrise engagement*

	Medium-Term Memory										Delayed Post-Test	
	Week 1		Week 2		Week 3		Week 4		4-Week Average			
Number of Participants	n=40		n=36		n=28		n=18		n=42		n=22	
Mean/Standard Dv	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Control Group	7.35	2.08	7.72	1.96	9.36	0.63	6.78	1.39	7.57	1.51	11.8	1.35
Experimental Group	7.23	1.74	6.25	2.78	6.93	3.25	8.22	2.5	6.51	2.17	11.1	5.14

5.2.3. Adjusted for full Memrise engagement

Lastly, results were adjusted for full participation with the Memrise application, with only data from participants who recorded consistent engagement with the application in every week for the duration of the experiment being considered for analysis, and compared with an equivalent number of top-scoring participants from the control group.

Table 5: Results for MTM and DPT Tests - *Adjusted for full Memrise engagement*

| | Medium-Term Memory | | | | | | | | | | Delayed Post-Test | |
	Week 1		Week 2		Week 3		Week 4		4-Week Average			
Number of Participants	n=16		n=16		n=12		n=16		n=16		n=16	
Mean/Standard Dv	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Control Group	7.56	1.76	7.63	2.15	9.5	0.55	5.56	1.12	7.36	1.09	12.4	1.09
Experimental Group	8.19	0.75	8.06	2.15	9.67	0.52	8.25	2.67	8.38	1.0	13.2	4.14

5.3. Medium-term memory

To ascertain statistical significance, *t*-tests were performed on the 4-week averages for the MTM tests and gave the following results, reported in tables 6 - 8 below;

Table 6: MTM Memory - *t*-**Test for** *overall results*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	6.40675	6.651515152
Variance	4.44043	3.195526696
Observations	21	22
Hypothesized Mean Difference	0	
df	39	
t Stat	-0.4098	
P(T<=t) one-tail	0.34209	
t Critical one-tail	1.68488	
P(T<=t) two-tail	0.68417	
t Critical two-tail	2.02269	

MTM results for the experimental group (M = 6.41, SD = 2.17, n = 22) were hypothesised to be greater than the control group (M = 6.65, SD = 1.79, n = 22). The difference however, was not significant, $t(39) = -0.4098$, $p = 0.342$ (1 tail).

Table 7: MTM Memory - *t*-Test for results *adjusted for minimal Memrise engagement*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	6.507576	7.57197
Variance	4.702321	2.29087
Observations	22	22
Hypothesized Mean Difference	0	
df	38	
t Stat	-1.88789	
P(T<=t) one-tail	0.033347	
t Critical one-tail	1.685954	
P(T<=t) two-tail	0.066695	
t Critical two-tail	2.024394	

MTM results for the experimental group (M = 6.51, SD = 2.11, n = 22) were hypothesised to be greater than the control group (M = 7.57, SD = 1.51, n = 22). Results, however, were significant in favour of the control group, $t(38) = -1.89$, $p = 0.033$ (1 tail).

Table 8: MTM Memory - *t*-Test for results *adjusted for full Memrise engagement*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	8.375	7.364583
Variance	0.990079	1.184896
Observations	8	8
Hypothesized Mean Difference	0	
df	14	
t Stat	1.937842	
P(T<=t) one-tail	0.03654	
t Critical one-tail	1.76131	
P(T<=t) two-tail	0.07308	
t Critical two-tail	2.144787	

MTM results for the experimental group (M = 8.38, SD = 1.0, n = 8) were hypothesised to be greater than the control group (M = 7.36, SD = 1.09, n = 8). Results were significant, $t(14) = 1.94$, $p = 0.037$ (1 tail) in favour of the experimental group.

In summary, for MTM recall tests, learning outcomes when measured by taking an average score achieved by participants over 4 separate tests over a period of 4 weeks were insignificant

when analysing overall results, including all participants who failed to engage with Memrise and poorly scoring participants in the control group.

When adjusting for minimal Memrise engagement, results were significant in favour of the control group, indicating that on average the control group outperformed the experimental group when discounting weak scoring participants and participants who did not engage with the Memrise materials during the given learning-phase.

When adjustments were made for full Memrise engagement however, and only participants who performed well on DPT tests were counted from the control group, results were significant in favour of the experimental group, showing that once all poorly scoring participants were eliminated from the results of both groups, the experimental group was shown to statistically outperform the control group.

5.4. Delayed post-test

T-tests were also performed on the DPT tests over all conditions of analysis, which gave the following results, reported in tables 9 - 11 below;

Table 9: DPT Memory - *t*-Test for *Overall Results*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	8.8	9.05
Variance	25.51052632	13.41842
Observations	20	20
Hypothesized Mean Difference	0	
df	35	
t Stat	-0.179192025	
P(T<=t) one-tail	0.42941013	
t Critical one-tail	1.689572458	
P(T<=t) two-tail	0.85882026	
t Critical two-tail	2.030107928	

DPT results for the experimental group (M = 8.8, SD = 5.05, n = 20) were hypothesised to be greater than the control group (M = 9.05, SD = 3.66, n = 20). Results however, were insignificant, $t(35) = 0.179$, $p = 0.43$ (1 tail).

Table 10: DPT Memory - *t*-Test for results *Adjusted for minimal Memrise engagement*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	11.13636364	11.81818
Variance	26.40454545	1.813636
Observations	11	11
Hypothesized Mean Difference	0	
df	11	
t Stat	-0.425696821	
P(T<=t) one-tail	0.339269185	
t Critical one-tail	1.795884819	
P(T<=t) two-tail	0.678538369	
t Critical two-tail	2.20098516	

DPT results for the experimental group (M = 11.14, SD = 5.14, n = 11) were hypothesised to be greater than the control group (M = 11.82, SD = 1.35, n = 11). Results however, were insignificant, $t(11) = 0.43$, $p = 0.34$ (1 tail).

Table 11: DPT Memory - *t*-Test for results *Adjusted for full Memrise engagement*

t-Test: Two-Sample Assuming Unequal Variances

	EG	CG
Mean	13.1875	12.375
Variance	17.13839286	1.196429
Observations	8	8
Hypothesized Mean Difference	0	
df	8	
t Stat	0.536698054	
P(T<=t) one-tail	0.303037661	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.606075323	
t Critical two-tail	2.306004135	

DPT results for the experimental group (M = 13.19, SD = 4.14, n = 8) were hypothesised to be greater than the control group (M = 12.38, SD = 1.09, n = 8). Results however, were insignificant, $t(8) = 0.54$, $p = 0.303$ (1 tail).

As can be seen from the results of the statistical analysis above, all results for DPT recall tests were insignificant to a $a = 0.05$ level, however, the final full engagement condition proved

moderately less likely than the previous two conditions, with the experimental group obtaining a higher average than the control group.

In summary, for DPT recall tests, learning outcomes when measured by a DPT vocabulary recall test that tested vocabulary items learned at periods of 1, 2, and 3 weeks prior to the test were insignificant when analysing overall results, including all participants who failed to engage with Memrise and poorly scoring participants in the control group.

When adjusting for minimal Memrise engagement, results also lacked statistical significance.

When adjustments were made for full Memrise engagement and only participants who performed well on the DPT test were counted from the control group, results were also insignificant however a higher mean average result was achieved by the experimental group, indicating that once all poorly scoring participants were eliminated from the results of both groups, the experimental group outperformed the control group, though not to a statistically significant degree.

5.5. Participant questionnaire

Participation in the participant questionnaire was voluntary. Overall, 14 responses were submitted online by participants following the completion of the MTM and DPT tests at the end of the 4th week of the experiment. 9 participants came from the control group and 5 from the experimental group (ID numbers: 8, 7, 10, 11, 13, 17, 21, 22, 26, 33, 34, 40, 38, 44), unfortunately providing a mismatch between groups meaning that any comparisons made will be subsequently reported in percentages and are naturally to be treated accordingly.

The first 7 questions on the questionnaire were identical for both the experimental and control groups and addressed participants' general learning behaviour and attitudes towards MALL integration in their English classes. In addition to these 7 initial questions, the experimental group were asked a further 4 questions pertaining specifically to using the Memrise application, in order to address participant attitudes and experiences of using the application during the experiment. Results are reported below under the headings of the respective questions;

1) ***Which of the following methods do you normally use to study English vocabulary?*** *(Multiple answers possible)*

Of the 15 responses to this question, 47% of respondents reported using mobile phone applications to help them with English vocabulary learning, while 40% of respondents

indicated that they learned from their coursebook, and 13% of respondents reported making their own notes or flashcards. There were no responses reporting any other methods.

PRE-TEST LEARNING BEHAVIOUR

I learn using a favourite mobile/web app, 7, 47%

I learn from the coursebook, 6, 40%

I make my own notes/flashcards, 2, 13%
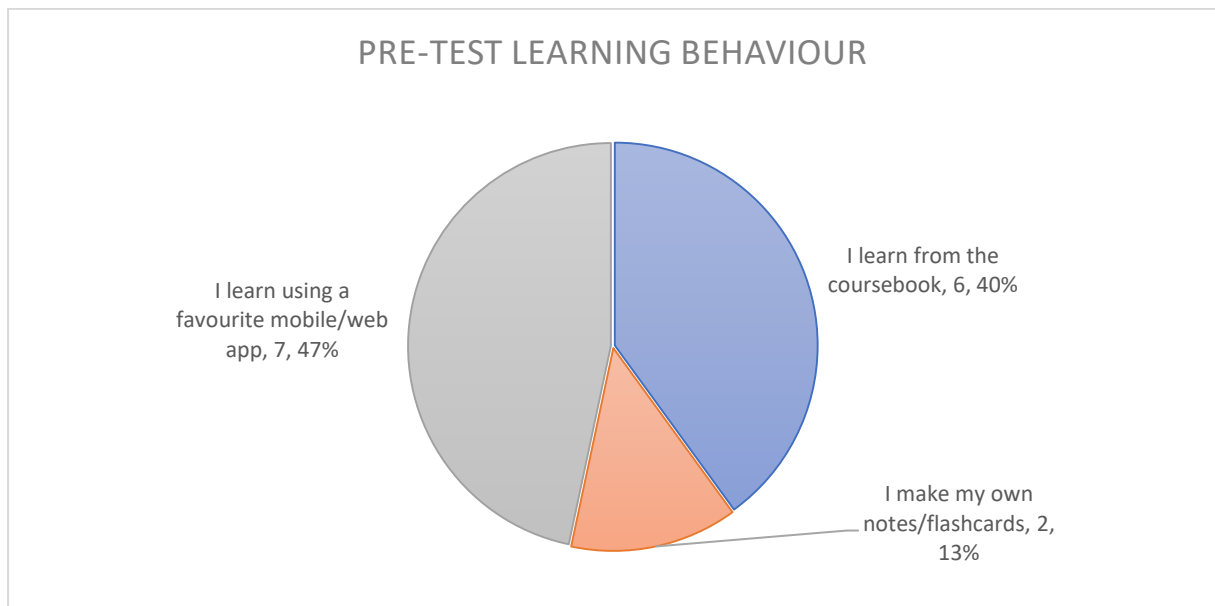
Figure 3: Respondents' pre-test vocabulary learning behaviour

2) *If you normally use one (or more) mobile/web application, please specify which one/s:*

Of the 8 responses to this question, 87.5% reported *Quizlet* (Quizlet.com) as their sole vocabulary learning application of choice. Interestingly, one participant responded as follows:

quizlet, but now also memrise, i like to mix it (ID = 10)

suggesting that the two applications have different strengths, or that possibly the combined use of the two applications allows the participant to leverage a certain learning effect. In light of further responses reported below, this also highlights the issue of individual learning styles as for participant 10, Memrise seems to have suited their particular style of learning as referenced by their continued engagement with the application during the experiment (see Appendix below).

3) *How often do you use mobile applications to help you with your vocabulary learning (in any language)?*

Most respondents reported frequent use of mobile vocabulary learning applications to help them with their vocabulary learning. 57% of respondents indicated that they used mobile applications *often* for their vocabulary learning needs, presumably these were the same 8 respondents who reported using Quizlet in question no.2 above. 14.3% of respondents indicated

that they never used applications, while the remaining ~29% of respondents reported at least moderate mobile application use. These results indicate a tendency in the respondents towards regular use of mobile applications for learning vocabulary, showing that the respondents in this study were already well-aware of the usefulness of mobile applications in aiding their language learning, and that in general, they already made regular use of MALL in their everyday language learning.
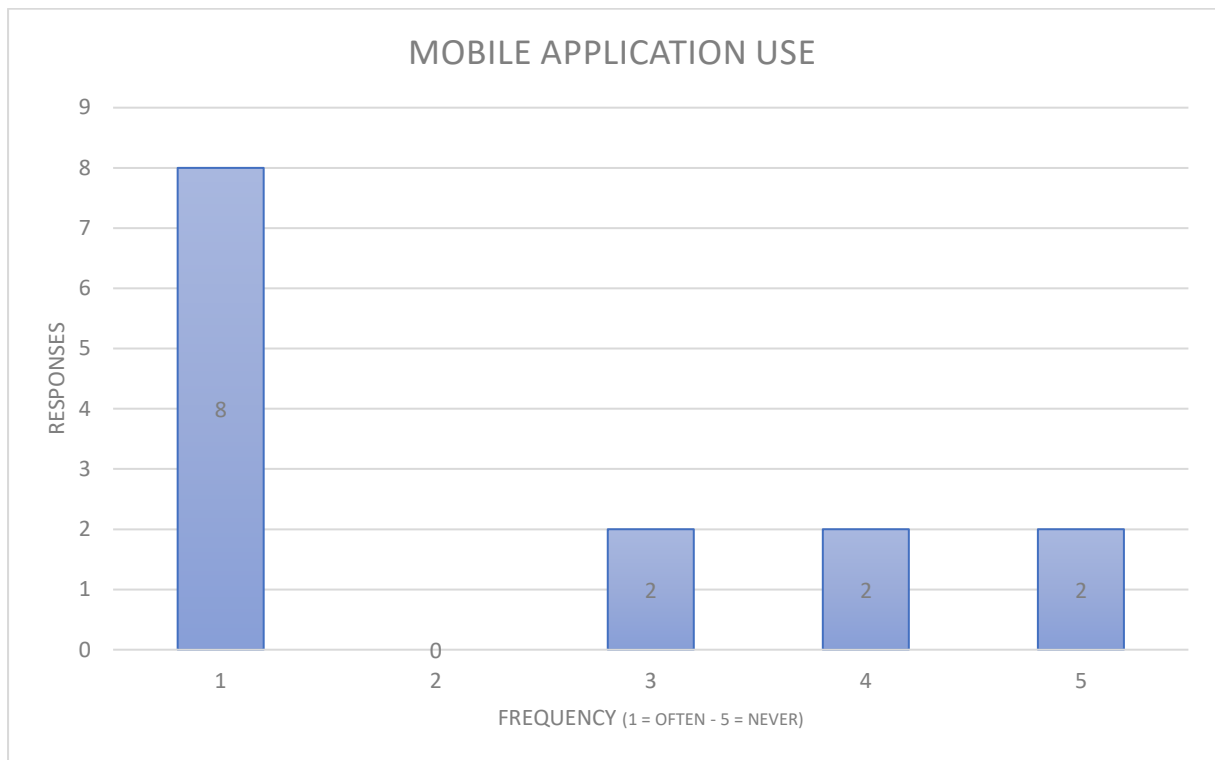
Figure 4: Respondents' pre-test mobile application use

In combination with answers to previous questions, it appears that respondents in the experiment were mostly frequent users of MALL applications despite these applications not yet forming part of their regular language learning programs.

4) *For each test, how often did you study the vocabulary?*

Overall, the majority of respondents reported that they had studied the vocabulary more than once, with a minority of 21% reporting having crammed for the test. The size of sample for the experimental group was however much too small to enable any definitive conclusions concerning the frequency of learning. 1 participant in the experimental group reported having revisited the vocabulary more than the other respondents, suggesting that Memrise had perhaps allowed or motivated more frequent study for this particular individual. However, the majority of the experimental group reported studying the vocabulary less frequently than the control group, so this interpreation must be rejected on these results.
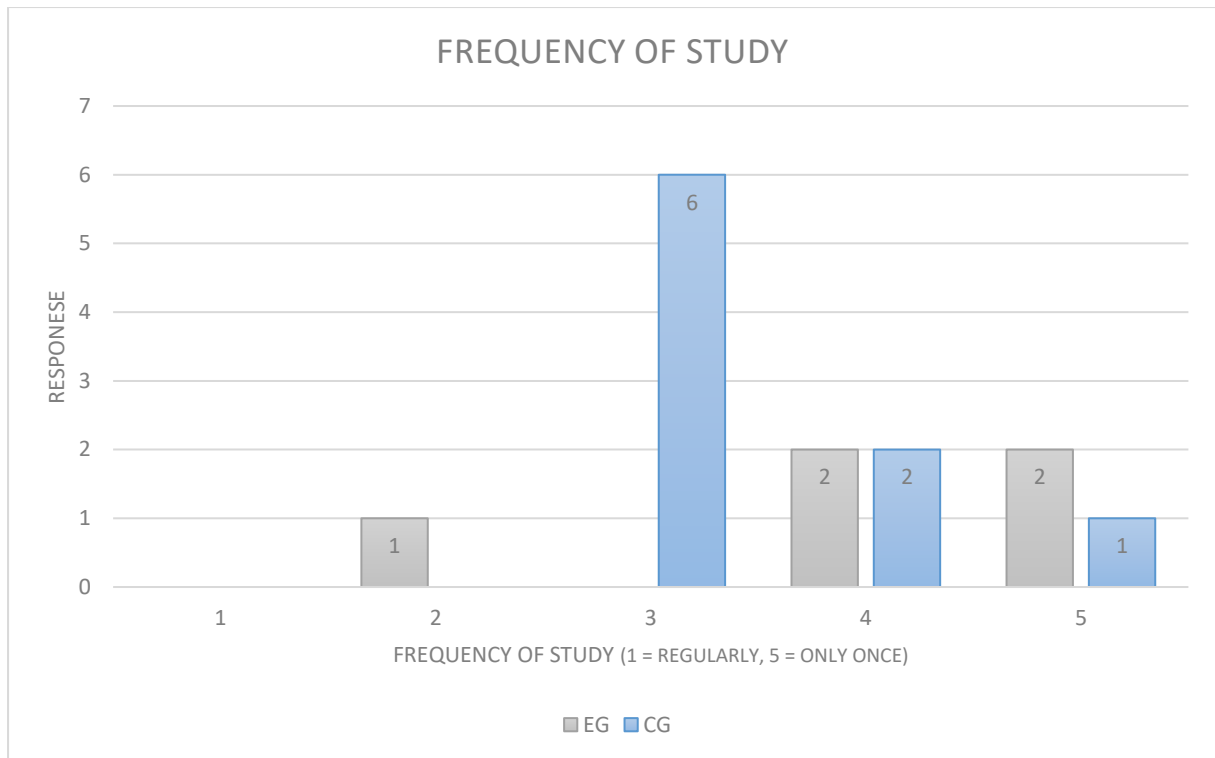
Figure 5: Respondents' frequency of study

5) *For each test, how much time did you spend studying?*

The majority of respondents (64.3%) reported having studied for less than 30 minutes, however, responses to this question revealed a slightly different learning behaviour between groups, with 60% of the experimental group reporting studying for 30 minutes or more, in comparison to only 22% of the control group. Here, it is clear that respondents in the experimental group spent more time studying.
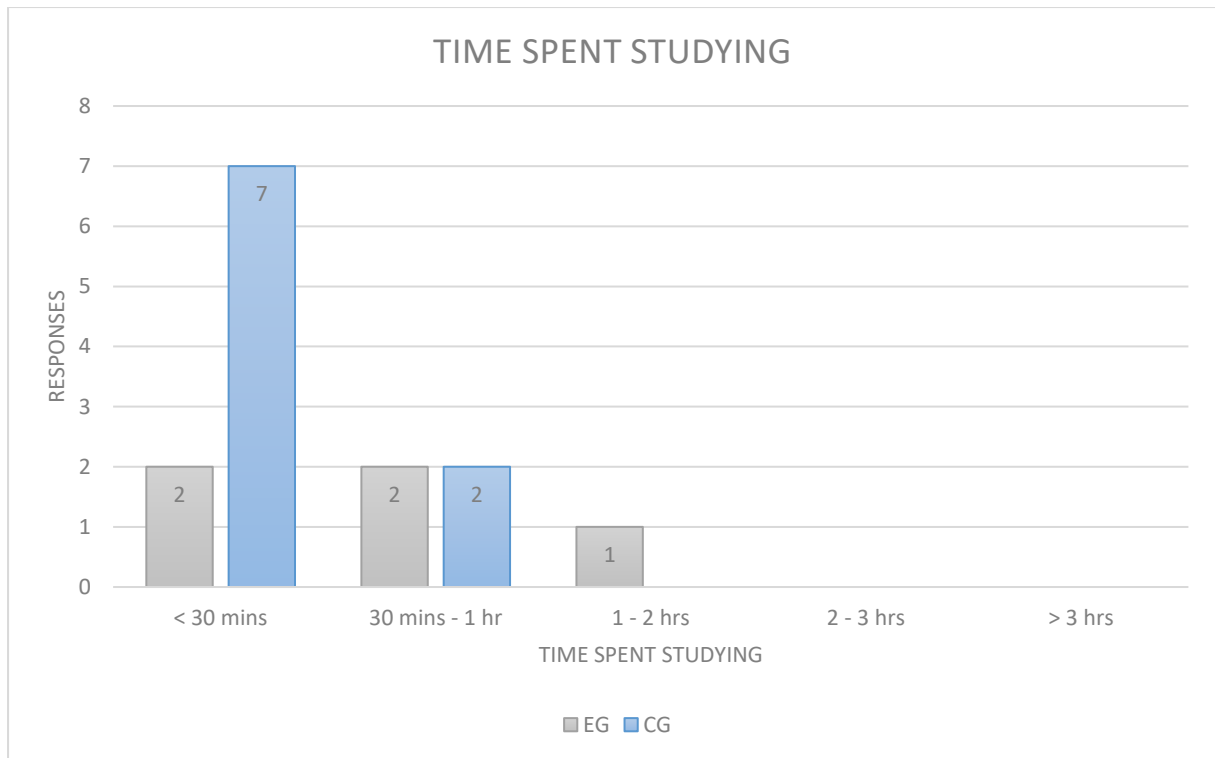
Figure 6: Respondents' time spent studying for each vocabulary test

6) *When did you study the vocabulary?* *(Multiple answers possible)*

Respondents mostly reported studying at school (33.33%), with a slightly greater tendency in the control group (EG=31%; CG=35%). The second most popular place of study was out of school during times that they would normally spend studying with a slightly greater tendency in the experimental group (EG=31%; CG=25%). Studying on the way to and from school was third most popular, with almost equal percentages between groups (EG=23%; CG=20%). Finally, 18% of respondents reported studying above and beyond what they normally would for the experiment, with slightly more of the control group indicating doing so (EG=15%; CG=20%). Unfortunately, no significant differences in learning behaviour can be seen from these results. The control group seem to have studied the vocabulary using paper-based methods in as much of a range of locations and times as the EG.
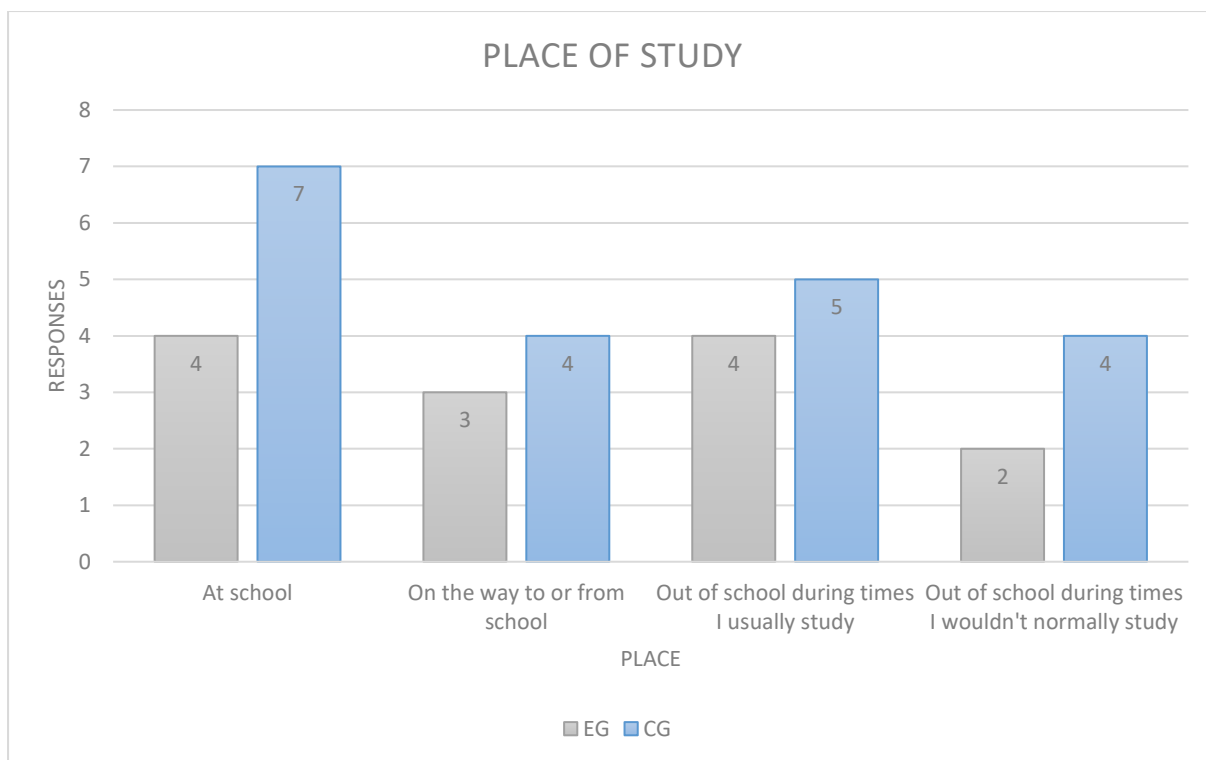
PLACE OF STUDY

Figure 7: Respondents' time and place of study

7) *Would you like to see teachers include the use of mobile technologies (not necessarily Memrise) in your English lessons, or as part of your English courses?*

As a penultimate question for both groups, respondents were asked if they supported the use of MALL applications in the EFL classroom as part of their everyday English lessons. The following results were obtained. 9 respondents replied in the positive, 1 replied in the negative and 3 said *maybe*.
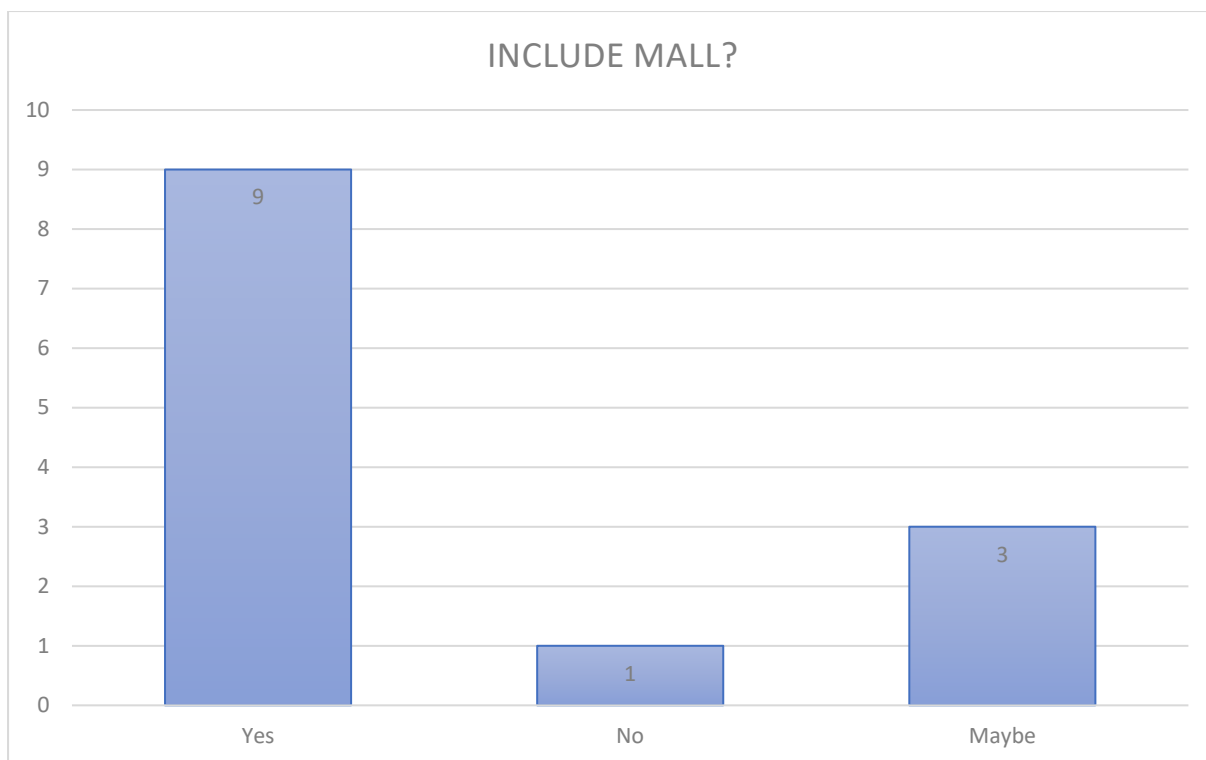
Figure 8: Respondents' readiness to integrate MALL into their EFL course

The final participant selected *other* and responded as follows;

> Yes, but more to ease the vocabulary learning at home and not in the lesson itself (ID = 10)

In summary, it appears that respondents were generally positive about the inclusion of MALL applications in their EFL lessons to help them with the learning of vocabulary, however, the final comment above highlights the fact that such applications should be employed out of school in order to help with learning, rather than form any significant part of classroom instruction.

The experimental group were asked four additional questions about their experiences and perceptions with regards to using Memrise.

8) *Did using the Memrise App help you to learn the vocabulary more quickly or efficiently than the method you normally use?*

First, the experimental group were quizzed on their perceptions of the application's usefulness in comparison to their normal method of vocabulary learning. The majority of respondents thought that it had actually not really helped them learn the vocabulary, with only 1 respondent replying that Memrise had been very helpful.

Figure 9: Helpfulness of Memrise

9) *What did you like most, or find most useful about using Memrise?*

Respondents were then asked what they found most useful. The following 4 responses to this question were of note.

> The app/system has a lot of potential but it doesn´t seem, like it was completely thought through. The animations with the flower growing is nice though. (ID = 22)

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> I really liked that you learn about five words, and then the next ones. Because with Quizlet you lern every word once and are then asked to remember 40 words, which takes a very long time. (ID = 10)

> the flower (ID = 7)

> I don't normally like studying with the book, so the app made it kind of fun to learn with the flower (ID = 38)

These responses raise a number of points. It seems that respondents enjoyed the gamification offered by the app's use of the flower metaphor, motivating learners to keep revising until the flower opens and blooms. Additionally, the comment concerning the number of words learned at a time, or in other words, the cognitive load of each of the two applications, Memrise and Quizlet is revealing. It seems this particular participant appreciated the small bytes (or chunks) of five words, as opposed to Quizlet's much larger load.

10)   What did you not like about using the Memrise App?

Respondents were asked to express their dislikes. The following responses were given;

> It just takes sooooo long. And I want to decide myself if and when I revise, the chapters should be completely apart from each other. (ID = 22)

> that it takes you hours to learn 5 words, escpecially when it's a word that you are already a bit familiar with, then it's quite frustrating to spent ages on repeating it (ID = 11)

> At one point, when I have already learned many words, it wasn't possible to repeat just the new words. (ID = 10)

> the audio option and the sentence-building (ID = 7)

> It took way too long to learn the vocabulary because it kept showing me old words which I already knew. (ID = 38)

These final comments on using Memrise raise a number of issues. The issue of time seems to have been a major factor in causing much of the discontent expressed, however, not necessarily length of time spent using the application, but rather the amount of time spent engaged in what the learners perceived as *productive learning*. It appears from the comments that respondents became frustrated at having to repeat words that they felt they already knew, and ultimately, at the length of time it took to achieve the opening of the flower, which Memrise, and not the respondents, determined as the point at which the vocabulary item had entered into LTM. As participant 22 remarked, "I want to decide myself if and when I revise", showing that the element of control over one's learning, and also in deciding when indeed one *knows* a vocabulary item, is important to learners and, to the disdain of participant 11, is taken away by Memrise.

Another significant point raised is that of the continual presentation and revision of words that the learner already feels they know. As noted above (see section 3.4. above) repetition is a pivotal factor in the learning of vocabulary, however, it appears that it can also be particularly frustrating for a learner to be continually *forced* to re-engage with an item of vocabulary if they feel as though they already know it.

11)   If you could, how would you improve Memrise? Are there any features you would add? Would you change anything?

Respondents suggested the following improvements to Memrise;

> Definitely split the chapters, improve the audio and picture system and somehow make, that it doesn´t take sooo long to make the flower open up. (ID = 22)

> change it to quizlet; find a way that each student can study in his own pace and not be held back or rushed through the vocabulary (ID = 11)

> I would add the option to repeat just the new words, and the option to chose some words to repeat, because I felt like the difficult words weren't repeated often enough. Oh, and really important, I would add a button to say that I meant the right thing (Quizlet has that) even though I wrote the wrong one, because that happens really quick, when you work with a laptop but it is very nerve-wracking it you now how a word is spelled, but just touched one wrong letter. (ID = 10)

> take the sentence-building option away (ID = 7)

> Make it take less time (ID = 38)

From these suggestions it can be seen that there are a number of issues with Memrise, and indeed with m-Learning in general. Concerning the issue of time that was raised in the comments for question 10, it appears that respondents were of the opinion that it took them too much time to learn what they perhaps could have learned quicker with other methods. Indeed, this supposition is supported by the data from question 5 above, where it can be seen that the experimental group spent more time studying. It appears as though the cause was the design of the application itself, which frustrated respondents.

Regarding the issue of learner control, participant 22 raises the importance of allowing learners to learn at their own pace and neither be hindered nor rushed. Learner autonomy, or the lack of it when it came to using Memrise, certainly plays a large part in determining learner motivation which in turn has been shown to affect learning outcomes.

A final point raised here concerns the modes of presentation offered by Memrise. Although audio and image options are promoted by the company behind the application as being "flashcards on steroids" (Memrise.com), unfortunately, it appears as though these options were not found to be useful by the respondents. Complaints were often heard during the 4 weeks of

the experiment about the quality of the audio, and the unpredictable nature of when they were and were not available in the application. These points are obviously points of consideration for the developers of the application, and, if considering the previous discussion on LTM consolidation, if these features were designed to operate seamlessly they would undoubtedly aid learners in consolidating deep and meaningful memories.

One final point concerning application design is raised by participant 10 and highlights the importance of learner control once more. Determining whether or not a user has simply made a mistake or not should be up to the user and not the application, thus allowing users to override decisions made by the application seems an important features that applications need to include in order to minimise frustration, especially with regards to mobile phones as the small screen size almost guarantees that mistakes will be made.

5.5.2. Closing comments

12)   *If there are any relevant comments, thoughts, or opinions that you would like to share, please feel free to share them below*

All respondents were given the opportunity to leave closing comments on any topic that they wished to talk about. Respondents generally responded positively to the experiment;

> Was a fun experiment 😊. I enjoyed finding out the results every Monday (ID = 22)

and left comments expressing the fact that they'd enjoyed participating in what many had treated as light competition and said that they had looked forward to finding out the results each week to see which group was in the lead. The comment below exemplifies the general tone;

> I really enjoyed not knowing if the other group was winning and then clicking on the spreadsheet on Monday to see the graphs and find out how my group had done (ID = 21)

Apart from general expressions of enjoying the feeling that they were in a form of group competition with each other, one participant left the following rather interesting and particularly relevant comment;

> It wasn't enough to know the German translation of a word but rather the meaning and where one can use that word. I thought that was very good an definetely helped me remember the vocabulary long - term. (ID = 44)

This comment refers to the format of the vocabulary tests and the fact that it was necessary, in order to answer the questions correctly, to have analysed vocabulary items to a deeper level in

LTM. The participant here seems to be well aware of the fact that knowing how to use a vocabulary item, i.e. knowing much more about an item than simply its form, is representative of a deeper consolidation in LTM and thus mastery of the item. This comment alone provides a small window into the processes in action that were elaborated above in section 3 concerning the vocabulary learning theories of researchers such as Nation (2013) and theories on LTM such as the DOP Hypothesis (Craik & Lockhart 1972; Lockhart & Craik 1990).

5.6. Limitations of the research

Due to the many limitations of this study, results should be treated with caution and conclusions drawn carefully. The timeframe over which the experiment was conducted was unfortunately far too short and therefore could not address long-term vocabulary retention of target vocabulary items adequately beyond the 4-week period. Thus, the study cannot be used to support definitive conclusions concerning LTM consolidation effects of MALL interventions. This of course leaves the question open as to whether or not the use of Memrise actually led to the transferral into LTM of the target vocabulary items, or if their effect was only experienced over a period of a month. Further studies should seek to address this concern by testing over longer time-periods, and by utilising delayed follow-up tests in order to ascertain true long-term consolidation effects.

A further limitation, or perhaps criticism that could be raised here concerns the initial ascertaining of the English level of the participants. Unfortunately, due to time constraints, pre-testing participants' existing vocabulary knowledge was not possible and, therefore, existing assessment data coupled with class teachers' assessments of the participants were used to gain insight into English level. This method of ranking could easily be criticised and regarded as being inadequate as both these measures, previous assessment data and teacher perceptions, were not directly related to participants' vocabulary knowledge and were drawn from a general view of general participant performance in their English lessons over a short period of 2 months (September and October). In retrospect, it would have been preferable to conduct pre-test vocabulary tests in order to test vocabulary knowledge specifically and thus gain a far more accurate and valid measurement of prior level.

A further limitation was of course the small sample-size of the study. Although such a limitation is not uncommon in MALL research as mentioned above, it is nevertheless a factor

that unfortunately remains unaddressed in this study and therefore invites criticisms of the nature that have been addressed in the previous discussion.

Though the experimental group did display significantly better MTM results, the effect was only discernible once the sample size was severely reduced, and all poorly performing participants were discounted. Although this manipulation was felt to be justified as Additionally, although the experimental group showed slightly better delayed post-test retention rates, the sample size was again much too small to draw any definite conclusions, suggesting that further research with larger sample sizes is certainly needed. These limitations of course leave the study open to previous criticisms of the type that have plagued other MALL studies and that have been highlighted in the discussion above, and mean that criticisms that were raised in the literature review could unfortunately not be addressed in this study.

The small sample size used here also proved detrimental to the ability to form any conclusive opinions concerning the exact learning behaviour of the two groups and thus prevented the adequate answering of the second research question. This unfortunately prevented any definitive conclusions to be made concerning the usefulness or efficacy of the *anytime, anywhere* paradigm offered by MALL applications with an EFL context and must be accepted as a major flaw.

6. Conclusions

To conclude, the implementation of the MALL vocabulary learning application Memrise in this study can be said to have produced mixed and inconclusive results, but nonetheless, results that show some promise for further research and offer a number of interesting discussion points. In terms of MTM tests, Memrise produced no statistically significant learning outcomes overall when using the full data set, or when adjusting for minimal engagement with the learning materials in Memrise in the second condition of analysis. These results show, that when considering participants regardless of performance or engagement with materials, no significant difference in learning outcomes was discernible. Additionally, the results show that once participants who had not engaged with materials in the experimental group were eliminated, regardless of their overall performance (thus retaining generally poor scoring participants who had indeed engaged with the MALL application), and compared with only the better scoring participants in the control group who could only be presumed to have engaged with the learning materials, results were significantly better for the control group, showing that

what was mainly being measured here was general ability, and not any significant effects of the learning methods themselves. However, once results were adjusted for full engagement with Memrise in the third condition of analysis, results were statistically significant in favour of the experimental group. This allows a very tentative claim to be made concerning the answering of the first research question. It can be concluded, that Memrise produced statistically significant, positive learning outcomes on medium-term vocabulary recall rates, however, only when comparing the small number of better-performing and more studious participants in the study. When taking into consideration the small number of fully engaging participants and thus resultingly small overall sample size (n = 16) however, these results must be treated with extreme caution, and used only to suggest that further research with larger sample sizes may well provide significant results.

Results for DPT tests all proved to be statistically nonsignificant. However, although results remained statistically nonsignificant for DPT vocabulary recall, it is worth noting here that the experimental group performed better than the control group on the DPT tests, and had they performed only marginally better than they did, results could have been statistically significant, showing that the beginnings of a significant effect may well have been observed in this study. Again, with a larger sample size, such an experiment could perhaps produce significant affects for DPT recall. To answer the remainder of the first research question, this shows that when it came to LTM consolidation, the use of Memrise seemed to have a small positive effect on LTM vocabulary retention, though results were not statistically significant. Further research on vocabulary retention rates with larger sample sizes would be needed to ascertain if these results were indeed attributable to the use of Memrise itself, or simply to increased time spent with the learning materials reported by participants in the experimental group (see analysis below).

In terms of relating these results to initial findings from the first two sections of this research study, it appears that the study conducted here was unable to reproduce the kinds of significant positive learning outcomes that have been previously reported in the literature and hypothesised to have resulted from the superiority of MALL applications to harness theories of learning such as Mayer's Cognitive Theory of Multimedia Learning, and other positive effects that one might expect as a result of the multi-modal presentation of vocabulary items that may in previous cases have leveraged the effects of the Depth of Processing Hypothesis and resulted in higher rates of LTM consolidation. Judging by the responses gathered from the questionnaire, it could be asserted here that it could well have been the design of Memrise that was at fault here, with respondents to the questionnaire being, in no uncertain terms, generally

critical of the application's overall design and sometimes finding it frustrating and demotivating.

Regarding the second research question, responses to the participant questionnaire revealed no significant differences in learning behaviour between the two groups, therefore, the hypothesis that the use of a MALL application would enable participants to utilise time that they would not normally be able to use in order to dip in and dip out of the learning materials, was not supported by the results of the questionnaire. Respondents in the control group appeared to display mostly identical learning behaviour in terms of time and place of study, except in showing that significantly more chose to learn the vocabulary at school. The only significant difference in learning behaviour that could be ascertained from the results was that of time spent engaging with the materials, with the experimental group generally spending more time learning. This could be interpreted as being a validation of the conclusions of such studies reported above (see section 2. Above) that have concluded that MALL applications have prompted participants to spend more time learning as they have been both motivating and convenient, allowing regular and efficient engagement with materials. Conclusions such as this have regularly been taken as being supportive of the often cited *anytime, anywhere* learning paradigm that is so often argued as one of the main reasons for MALL implementation. However, as the comments from experimental group respondents concerning the use of Memrise later showed, the increased amount of time spent by the experimental group engaging with the learning materials was predominantly a result of the design of the application itself, which forced participants to continually revise words that they felt they already knew, and therefore, cannot be attributed in this case to a rise in motivation or interest in learning.

Concerning Memrise-specific questions on the questionnaire, the issue of learner-control seemed to play a large part in the reasons why respondents expressed negative opinions towards the use of Memrise. Features that would have made their learning experience more profitable and thus more motivating were not provided, exercises were repetitive, time-consuming, and form-focused which actually hindered the learning process rather than facilitated it, and respondents seemed frustrated at the lack of control they had over their learning and ultimately the time it took them to master the vocabulary items in comparison to the time they would normally have spent learning using their course books or other paper-based methods. Conclusions that can be drawn from this are application design needs to be carefully considered and adequately implemented in any MALL application in order to facilitate the learning process and not hinder it, and that a poorly designed application can actually be more of burden to

language learners, a factor that must be taken very seriously in the design of any MALL implementation.

Concerning the final research question, however, and notwithstanding negative opinions expressed by the experimental group concerning the use of Memrise, the majority of respondents were generally positive about MALL integration in their EFL courses and would support such interventions in the future. Gameification of vocabulary learning seems to have been positively regarded by the experimental group, and although the time it took to open the application's *flower* was in the opinion of respondents far too long, the general concept was positively appraised. Added to this is the observation that the majority of respondents that replied to the questionnaire were already users of a rival MALL vocabulary learning application, namely Quizlet (Quizlet.com), suggesting that application use amongst SLLs of this age group is already widespread and that there is an openness to experiment with such technology in the achieving of learning goals as part of EFL courses at the high school level. It seems that with a much more competent and pedagogically-minded design, a MALL application that utilised the gameification concept to increase motivation during vocabulary learning and coupled this with better and more thoughtfully designed functionality overall and exercises which were more meaning- and language use-focused, would be enthusiastically adopted for the learning of EFL vocabulary by respondents of the age and language level of those in this study.

As a closing comment, it should be noted that the challenge regarding any technological implementation of MALL in the EFL language classroom is the design and implementation of interventions that can provide access to learning materials in a manner that complements the learning processes elaborated in previous sections. From this study, it appears that although Memrise promised much, significant design flaws seem to have prevented much of the expected and hypothesised potential from being realised in this study. It is of course essential that any MALL implementation promote the mental events that have been identified and elaborated in the discussion above that are essential for vocabulary acquisition to take place. Only then will it be possible to include MALL applications in scientifically and methodologically grounded language learning curricula, which, although significant effects on learning outcomes in MTM and small positive effects in DPT tests were observed here, this study was unfortunately far too small to provide firm support for.

It is evident that technology is able to deliver ever more complex and content-rich sensory data to the language learner, and this at an ever-increasing rate. However, the fact remains that any MALL application, for it to result in significant learning outcomes when compared to traditional paper-based methods, must aid the learner from a pedagogical perspective, from the perspective of the achieving of their learning goals and this with the mental apparatus of the human mind. Memrise, offered some glimmers of hope in this regard here, though in certain cases it appears to have hindered the learning process by forcing the participants in this study to engage in unnecessary form-based activities which were experienced as both frustrating and time-consuming. Positive attitudes in general towards MALL implementation, however, and promising effects on MTM and DPT results, suggest that a thoughtfully designed application would be enthusiastically adopted and may deliver the significant learning outcomes so often promised.

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Appendix

The following appendix contains all details relating to the vocabulary learning experiment described above, including all the raw data and results collected, all target vocabulary items, medium-term and delayed post-test memory tests administered, and all details relating to the online questionnaire including questions and answers given by participants.

Target vocabulary items

Target vocabulary items learned by participants in each week of the study, and in each of the 2 separate English classes are reproduced below;

Week 1
Class - 7A

	Unit 8 – Art		
Number	Vocabulary Item	German Translation	Example Sentence
1	skull	Schädel	Police discovered the remains of a human skull in a park early Sunday afternoon.
2	marble	Marmor	Marble bust stolen from Kent church
3	clergyman	Geistlicher	Senior citizen tricked out of cash by youngster who claims to be clergyman
4	testament	hier: Beleg, Nachweis	It's just a testament to how hard they wanted to win.
5	permanent exhibition	Dauerausstellung	If you climb the long stairs to the permanent exhibition, you can take in the 360-degree view of London.
6	rear	hier: Gesäß	Officer accused of spanking woman's rear is charged
7	filthy	schmuddelig	Choose your seat in the underground: Hard and clean or plush and filthy?
8	reluctant	widerwillig, zurückhaltend	Homeowners are reluctant to put their homes on the market when prices are so low.
9	hesitant	zögernd	I am always hesitant to talk about our future.
10	striking	hier: auffallend, bemerkenswert	He had a gentle expression and a friendly smile and bore a striking resemblance to Franz Schubert.
11	town councillor	Stadtrat, -rätin	An 18-year-old schoolboy officially becomes the youngest town councillor in the UK.
12	to mess with sb./sth.	sich mit jmdm. anlegen	Don't mess with Andy today – he's in a really bad mood.
13	outlet	hier: Ventil	Violence may be an outlet for frustration, but it will not solve any problems.
14	law enforcement officer	Polizeibeamter, -beamtin	He faces numerous charges, including assault on a law enforcement officer.
15	to make a claim for sth.	einen Anspruch auf etw. geltend machen	She required round the clock care after the accident and made a claim for compensation.
16	beyond sb.'s control	außerhalb jmds. Kontrolle	The man himself is not too bothered about things beyond his control.
17	voluntarily	freiwillig	Two companies are voluntarily recalling about 99,000 products.
18	to branch out	neue Geschäftsfelder erschließen	An online retailer has branched out into product manufacture with a range of cycling accessories.
19	to tremble	hier: erschauern, schaudern	She trembled and tried to speak, but the soft words were incoherent.
20	bleak	öde, kahl	Uganda's food security future looking bleak
21	cut-price	ermäßigter Preis	Only a few cut-price video game systems left – buy now!
22	forceful	energisch, eindringlich	There was no sign of a forceful attempt to open the door.
23	to be expelled from	ausgeschlossen werden	Nun expelled from convent in Spain over Facebook
24	in conjunction with	in Verbindung mit	Offer not to be used in conjunction with any other offers or reduced-fee plans
25	to collaborate with sb.	mit jmdm. zusammenarbeiten	He has collaborated with many Indian artists on this CD.

Unit 8 – Famous Speeches			
Number	Vocabulary Item	German Translation	Example Sentence
1	alliance	Bündnis, Allianz	Students formed an alliance to stand up against bullying.
2	to dedicate sth. to sb.	jmdm. etw. widmen	This monument was dedicated to the many people who had lost their lives in the rescue operation.
3	to create	schaffen, erschaffen	According to religion, God created the world.
4	to be engaged in	verwickelt sein	The battalion was engaged in a fierce battle.
5	to surrender	aufgeben	The British refused to surrender to their enemies in WW II.
6	to dedicate oneself to	sich in den Dienst einer Sache stellen	She dedicated herself to helping the poor.
7	to deliver a speech	eine Rede halten	He delivered his speech in front of the Lincoln Memorial.
8	podium	Podium	There was a huge crowd. We could hardly see the podium.
9	quotation	Zitat	He started his speech with a quotation from a novel.
10	to appeal to the emotions of	an die Gefühle appellieren, die Gefühle ansprechen	The speaker tried to appeal to the emotions of the audience by talking about the fate of the children.
11	on the occasion of	anlässlich	On the occasion of their anniversary they got a pot plant.
12	far-reaching consequences	weitreichende Folgen	The flood had far-reaching consequences. All the houses were destroyed.
13	inspiring	anregend, inspirierend	The first speech was so inspiring that the crowd started to cheer immediately.
14	rhetorical	rhetorisch	I used many rhetorical tricks to convince my audience.
15	at the expense of	auf Kosten von	Never make jokes at the expense of others.
16	to owe	schulden	Sam owes me some money. I hope he gives it back.
17	failure	Scheitern	His business was a complete failure, it went bust.
18	bullet	(Gewehr-)Kugel	Three bullets hit him in the back.
19	degree	(akademischer) Abschluss	She holds two degrees from two different universities.
20	occupation	Besetzung	Under Soviet occupation, people were not allowed to travel freely.
21	to excel in	sich auszeichnen in	After school they excelled in their sports.
22	injustice	Ungerechtigkeit	They wanted compensation for the injustices of the past.
23	to deny	hier: (Rechte) verweigern	The hooligans were denied entry to the stadium.
24	to harm	schaden	Eating raw apples won't harm you.
25	unique	einzigartig	This piece of art is unique, there is only one like it.

Unit 8 – Art Continued			
Number	Vocabulary Item	German Translation	Example Sentence
1	sincerity	Aufrichtigkeit	The main opposition party cast doubts on the sincerity of the proposal.
2	elaborate	kunstvoll, ausgefeilt	They also play movies on elaborate home theatre systems.
3	hastily	hastig	The Council Member held a hastily arranged news conference on the steps of City Hall.
4	notorious	berüchtigt	Tories get £10.000 gift from son of notorious arms dealer
5	unconventional	eigenwillig, unkonventionell	Their success is based on an unconventional move the company made in 2010.
6	quirky	skurril, schrullig	How can you ignore a fashion so quirky, such fun and yet so stylish?
7	to masquerade	sich verkleiden, etw. vorgeben	What we don't need is a new tax masquerading as a green measure.
8	to elevate	erhöhen, erheben	Make your home ready for any flood by elevating materials that could be damaged in your basement.
9	allusion	Anspielung	I made no allusion at all to the letter she had sent me.
10	texture	Struktur, Beschaffenheit	Its texture and flavour are hard to beat.
11	to complement each other	einander ergänzen	The firm is led by two strong partners who are complementing each other perfectly.
12	prodigy	Wunderkind, Ausnahmetalent	An unprecedented prodigy career begins, leading him to all major cities in Europe.
13	adorable	bewundernswert	Her company makes adorable paper goods geared towards children.
14	scam	Betrug, Schwindel	People behind the scam are misusing the corporate name of a legitimate Dayton company.
15	to heap praise	Lobpreisungen aussprechen	He admitted that it was a tough game and heaped praise on his players.
16	aesthetic	schön, ästhetisch	A family doctor and a nurse have set up an aesthetic medicine clinic in Hale Barns.
17	dreary	trostlos, düster	The return to the work week brings a cloudy, dreary, cool and breezy day.
18	to be shortlisted	in die engere Auswahl gekommen sein	His first two novels were each shortlisted for National Book Awards.
19	aversion	Abneigung	Aversion to using borrowed money to enhance trading has lingered since the financial crisis.
20	to shackle	fesseln	He waved his shackled hands to his family in the courtroom as he sat down.
21	aforementioned	obengenannt, bereits erwähnt	The aforementioned vehicles require a software fix to correct the problem.
22	debacle	Katastrophe, Debakel	Petrol producers alone were to blame for the debacle.
23	resemblance	Ähnlichkeit	It bears an eerie resemblance to real-life events that unfolded later in the summer.
24	devotion	Hingabe	Our chef's gourmet creations, prepared with devotion and talent, excite even the most demanding of palates.
25	superimposed	aufgesetzt, darübergelegt	She then superimposed each image on top of the other.

Number	Vocabulary Item	German Translation	Exmple Sentence
1	confident	selbstbewusst, selbstsicher	She was confident that she would deliver a good speech.
2	to contribute	beitragen	If we all contribute to the project, we won't fail.
3	intention	Absicht	Her intentions were to stop the violence in the area.
4	announcement	Ankündigung	An announcement was made that the train would be late.
5	gesture	Geste	People communicate with gestures as well as with words.
6	face-to-face	Auge in Auge	Sometimes it is better to talk to people face-to-face.
7	expectation	Erwartung	Her results were beyond her wildest expectations.
8	healthcare	Gesundheitswesen	The President's healthcare initiative earned him much criticism.
9	to settle for	sich zufriedengeben mit	I would settle for a trip to Northern Italy.
10	rotten	verdorben, verfault	The supporting structure was rotten.
11	gorgeous	herrlich, fantastisch	The weather on the island was gorgeous.
12	to grin	grinsen	I looked at her and she grinned back.
13	to be flattered	geschmeichelt sein	I was really flattered when you invited me to your party.
14	rubbish can	Mistkübel	Would you put out the rubbish can, please?
15	to be suspended	seines Amtes enthoben sein, suspendiert sein	When they found out, he was suspended immediately. Now he is awaiting his trial.
16	to be able to afford	sich leisten können	Many families are not able to afford a winter holiday.
17	worthwhile	lohnenswert	It is certainly worthwhile to study foreign languages.
18	passionate	leidenschaftlich	She was quite passionate about it, I could hardly stop her.
19	to voice one's opinion	seine Meinung äußern	Of course you have the right to voice your own opinion!
20	precision	Genauigkeit	The ball hit the bar with utmost precision.
21	estimate	Schätzung	Estimates say that the total loss will be much higher.
22	significant	bedeutend	Her remarks were highly significant. A great contribution.
23	occasional	gelegentlich	Apart from an occasional trip to the country we stay here.
24	workload	Arbeitspensum	She managed to cope with the workload really well.
25	to be bombarded with	bombardiert werden mit	In May my e-mail account was bombarded with junk mail.

Unit 8 – Famous Speeches – Continued

Week 3

Class - 7A

	Belief and Opinion		
Number	Vocabulary Item	German Translation	Example Sentence
1	obsessive	besessen sein von	She is rather obsessive about her beliefs
2	ideology	Ideologie/Weltanschauung	If you have no proof at all then your beliefs are no better than ideolgy
3	to be convinced about/of sth	überzeugt sein von	I am completely convinced that we landed on the moon
4	intellectual	intellektuell/geistig	To formulate a rational opinion you need to use your intellectual capacities
5	socialist	sozialist	Socialist political thought emerged as a rival to classical liberalism in the 19th century
6	conservative	konservativ	Conservative political opinions emphasise the value of traditional institutions and practices
7	eccentric belief system	exzentrische Glaube	Scientology is a rather eccentric belief system
8	radical	radikal/drastisch	Some people support quite radical change in society
9	extreme viewpoint	radikaler Standpunkt	Supporting the forced confiscation of the wealth of the rich is quite an extreme viewpoint
10	moderate	gemäßigt	With all the extremism around nowadays, you'd be forgiven for thinking that people with more moderate views had disappeared
11	dedicated	engagiert	One can only remain dedicated to unfounded beliefs for so long
12	committed	verpflichtet/gebunden	A true believer is committed to their beliefs
13	a firm believer in	etw. fest glauben	She is a firm believer in democracy
14	in my view	meiner Ansicht nach	In my view this behaviour is unacceptible
15	to my mind	meiner Meinung nach	To my mind there has to be a better way to do things
16	left/right wing	links/rechts (Kontext: Politik)	Her political opionions are seriously left/right wing
17	to hold a view/opinion	eine Ansicht/Meinung vertreten	Until he got married he held the opinion that men didn't need to clean up after themselves
18	to have your doubts about st	Zweifel haben	She had her doubts about him when he turned up in a multi-coloured christmas jumper
19	to be of the opinion that	der Meinung sein, dass...	I am of the opinion that school should begin no earlier than 09:00am
20	if you ask me	wenn du mich fragst	If you ask me, plastic packaging should just be banned completely
21	point of view	Perspektive	A point of view worth considering is that it could just be turtles all the way down
22	to maintain an opinion	bei einer Meinung beharren	He maintained the opinion that cows milk should simply not be consumed by humans
23	to be in favour of sth.	für etwas sein	She was in favour of the suggestion
24	to be opposed to sth.	gegen etwas sein	He was opposed to the idea
25	to be a strong believer in sth.	von etw. überzeugt sein	They were strong believers in getting plenty of exercise before breakfast

Unit 4 – Making a Difference

Number	Vocabulary Item	German Translation	Exmple Sentence
1	to donate (money to)	Geld spenden an	Local businesses have donated money to the fund as well.
2	healthcare	medizinische Fürsorge	Worker obesity costs more than healthcare can afford.
3	to raise money	Geld sammeln	Teens raise money for national pet cancer organisations.
4	poverty	Armut	The Census Bureau reported that the poverty rate was up.
5	adulthood	Erwachsenenalter	The Centre will target patients from infancy to adulthood.
6	to have access to	Zugang haben zu	Germany's police authorities have not had access to him.
7	to play a major role	eine große Rolle spielen	Dieting plays a major role in the American lifestyle.
8	volunteering	ehrenamtliche Arbeit	Volunteering in your spare time looks great on your CV.
9	drought	Dürre	The drought in Alabama increased the threat of fires.
10	financial support	finanzielle Unterstützung	Financial support for local projects has been cut by 25%.
11	fundraising	Spendensammlung	Tina has asked me to help out at her fundraising event.
12	cashier	Kassier/in	David Reid threatened the cashier at a licensed grocer.
13	to be caught in a dilemma	sich in einer Zwickmühle befinden	He is caught in a dilemma whether to tell his friend or keep it a secret.
14	drug addict	Drogenabhängige/r	A drug addict robbed his own granny.
15	siblings	Geschwister	As children we never fought like most siblings do.
16	remarkable	bemerkenswert	It has been a remarkable run.
17	considerable	beträchtlich	A considerable amount of money was stolen this evening.
18	to make ends meet	mit seinem Geld auskommen	My mum worked part-time and so we made ends meet.
19	disobedience	Ungehorsam	I am not saying disobedience is OK.
20	unjustifiable	nicht zu rechtfertigen	Police used unjustifiable brutality against protesters.
21	to initiate	initiieren	New measures were initiated to help the poor.
22	to be targeted at	gerichtet sein an	The product was targeted at those over 40.
23	likelihood	Wahrscheinlichkeit	Stress increases the likelihood of having an accident.
24	to evade paying taxes	das Zahlen von Steuern vermeiden	Thousands of millionaires are doing what they can do to evade paying taxes.
25	to spearhead a campaign	an der Spitze einer Kampagne stehen	Pharmacists to spearhead campaign on anti-malaria policy

Week 4

Class - 7A

Unit 4 – Health Issues			
Number	Vocabulary Item	German Translation	Exmple Sentence
1	**addictive**	süchtig machend	It's a fun and addictive online puzzle game.
2	**allergy**	Allergie	Every product is dermatologically and allergy tested.
3	**to shrink in size**	in der Größe abnehmen	Phones will still shrink in size but will continue to have exciting features.
4	**fine dining**	fein essen gehen	Two stylish restaurants provide the perfect setting for fine dining.
5	**to be made fresh to order**	frisch auf Bestellung zubereitet	We specialise in sandwiches made fresh to order.
6	**homemade food**	hausgemachtes Essen	Homemade food and a variety of snacks served all day
7	**special request**	Sonderwunsch	On special request we also deliver 5 kg tins.
8	**high blood pressure**	hoher Blutdruck	One in three Britons suffers from high blood pressure.
9	**coronary disease**	Herz-Kreislauf-Erkrankung	Researchers have developed a plan that could reduce the risk of coronary disease by 81%.
10	**eating disorder**	Essstörung	Elite athletes are prone to developing eating disorders.
11	**partial**	teilweise	After returning from their holidays, the Andersons only received a partial refund.
12	**to enforce a ban**	ein Verbot erzwingen	The city will enforce its ban on long-term parking even during special events.
13	**to operate a restaurant**	ein Restaurant führen	The Heinzers have operated the restaurant since 1982.
14	**to fulfil a need**	ein Bedürfnis befriedigen	Does poetry fulfil a need in your life?
15	**to qualify for sth.**	hier: sich für etw. eignen	In order to qualify for an internship, you must have completed your basic studies.
16	**stubborn**	stur, hartnäckig	It easily washes stubborn films of pesticides off fruit.
17	**to execute a task**	eine Aufgabe ausführen	The programme can execute an additional task after saving an attachment.
18	**impairment**	Beeinträchtigung	There are studies suggesting that diabetes can lead to hearing impairment.
19	**physical disability**	körperliche Beeinträchtigung	Having a physical disability does not mean you must become less active.
20	**to relish sth.**	etw. genießen	Growing up in Lebanon, I relished watching Egyptian television series.
21	**to stand up for sb.**	für jmdn. eintreten	I wanted the people to know I stood up for them.
22	**to build up self-confidence**	Selbstvertrauen aufbauen	Do you use alcohol or drugs to build up self-confidence?
23	**to compensate for sth.**	Ersatz für etw. leisten	Companies should compensate their staff fairly for the valuable services they provide.
24	**to get sth. off one's chest**	sich etw. von der Seele reden	He told me all about it and got it off his chest.
25	**to implement**	einführen	Japan successfully implements power naps at work

Class - 6A

Number	Vocabulary Item	German Translation	Exmple Sentence
	Unit 3 – The Blue Planet		
1	reusable	wiederverwendbar	Reusable bags are more environmentally friendly.
2	biodegradable	biologisch abbaubar	Biodegradable materials will reduce pollution through waste considerably.
3	climate change	Klimawandel	Carbon dioxide contributes to climate change.
4	to cause damage to	schädigen	Floods caused a lot of damage to the houses in the area.
5	to raise awareness	das Bewusstsein erhöhen	Before you can change anything you have to raise public awareness regarding the urgency of this problem.
6	to waste natural resources	natürliche Ressourcen vergeuden	We must stop wasting valuable natural resources now!
7	renewable	erneuerbar	Wind power is a cost-effective renewable energy source.
8	energy source	Energiequelle	Oil is probably the most precious energy source we have.
9	bottle bank	Glassammelstelle	Glass bottles are collected in bottle banks for recycling.
10	landfill site	Mülldeponie	Local residents are strongly against the new landfill site.
11	to become extinct	aussterben	Tropical birds unfortunately have become extinct here.
12	emissions	Gasausstoß, Emissionen	Emissions from traffic have doubled in a very short time.
13	to break down	zusammenbrechen	When she heard the news, she broke down in tears.
14	fragment	kleiner Teil, Fragment	Tiny fragments of the bullet were found in his wound.
15	to be moved to tears	zu Tränen gerührt sein	She was moved to tears when she saw her baby again.
16	response	Antwort, Reaktion	His response was to call my superiors and complain.
17	abbreviation	Abkürzung	UN is an abbreviation for United Nations.
18	raw material	Rohmaterial	Raw materials are needed for the production of goods.
19	carbon footprint	Kohlendioxyd-Fußabdruck	The carbon footprint of a trip to the US is enormous.
20	as a result of	auf Grund von, infolge	Much food is thrown away as a result of overproduction.
21	to account for	verantwortlich sein für	Transport accounts for a large part of carbon dioxide emissions.
22	equivalent to	gleichwertig mit	This behaviour is equivalent to racism.
23	status quo	gegenwärtiger Zustand	If the status quo is changed a civil war might break out.
24	to tackle	angehen, in Angriff nehmen	To tackle this problem you have to find partners first.
25	sustainable	nachhaltig	Sustainable growth is what companies hope for.

Medium-term memory tests with correct answers

Details of all 4 weekly medium-term memory tests administered during the vocabulary experiment are given below.

Week 1

Class - 7A

Number	Vocabulary Item	Test Sentence
	Unit 8 – Art	
1	permanent exhibition	A display that is never taken down is a _____
2	rear	The back of something is also called the _____
3	reluctant	If you are unwilling to do something you are _____
4	hesitant	If you are uncertain or undecided before doing something you are _____
5	striking	If something is noticeable or obvious it is said to be _____
6	beyond sb.'s control	If somebody cannot command authority over something it is said to be _____
7	to tremble	If you are shaking uncontrollably you are _____
8	forceful	If something is full of power it is _____
9	to be expelled from	If somebody is thrown out, they have been _____
10	to collaborate with sb.	If you cooperate with somebody you are said to have _____

Class - 6A

Number	Vocabulary Item	Test Sentence
	Unit 8 – Famous Speeches	
1	to create	To bring something into being is to _____ it.
2	to be engaged in	To participate in a fight with somebody is to be _____ a fight with them.
3	to surrender	To capitulate or give in during a fight is to _____
4	to dedicate oneself to	To commit youself to sombody or to a cause is to _____ to somebody/something.
5	podium	A platform upon which you can deliver a speech is called a _____
6	inspiring	If something is stimulating or motivating it is _____
7	rhetorical	Stylistic or persuasive language is known as _____ language.
8	at the expense of	To do something at a cost to something or someone else is to do it _____ of something/someone.
9	failure	If your business has a lack of success it is a _____
10	to excel in	If you are brilliant at something then you _____ in it.

Week 2

Class - 7A

	Unit 8 – Art – Continued	
Number	Vocabulary Item	Test Sentence
1	**sincerity**	If you say something with honesty you have said it with _____
2	**hastily**	If you do something in a hurry you do it _____
3	**quirky/unconventional**	If your behaviour is peculiar or unusual then you are _____
4	**texture**	Food can have both flavour and _____
5	**adorable**	If something is just lovable, cute, or sweet, it is simply _____
6	**to heap praise**	If you compliment, congratulate, or express admiration for somebody then you _____ on them.
7	**aforementioned**	If something has been said before it is the _____
8	**resemblance**	If something is similar to something esle then it bear a _____ to it.
9	**devotion**	If you apply yourself to something and do it with love and enthusiasm you do it with _____
10	**superimposed**	If a picture is layered on top of another so that you can still see both of them, then it has been _____

Class - 6A

	Unit 8 – Famous Speeches – Continued	
Number	Vocabulary Item	Test Sentence
1	**to contribute**	If you do your bit for society you _____ to society.
2	**intention**	If you have an aim or a goal then you have an _____
3	**face-to-face**	If you talk to someone in person then you talk to them _____
4	**expectation**	If you have a strong belief that something will happen then you have an _____
5	**to settle for**	If you agree to something though it is not the best, then you _____ it.
6	**to be flattered**	If someone is very kind to you or praises you, then you could say that you are _____
7	**worthwhile**	If doing something brings benefit or value to your life, doing it was _____
8	**to voice one's opinion**	If you tell someone exactly what you think about something then you _____
9	**significant**	If something is worthy of attention or is important then it is _____
10	**to be bombarded with**	If people keep asking you questions then you are being _____ questions

Week 3

Class - 7A

	Belief and Opinion	
Number	Vocabulary Item	Test Sentence
1	obsessive	If my beliefs completely dominate my life then I am _____ about my beliefs.
2	ideology	If my beliefs are based upon the way I would like things to be rather than the way things are, then my beliefs are just _____
3	to be convinced about/of sth	If I am sure about my own opinion then I am _____ it.
4	radical	Some people would like to see complete change in society, they would like to see _____ change.
5	moderate	If my views are reasonable and commonplace then I have _____ views.
6	committed/dedicated	If I am a true believer in something then I am _____ to it.
7	to have your doubts about sth	If I do not think that a politician is trustworthy then I _____ them.
8	point of view/opinion	If I tell you what I think, or give you my perspective on things, then I tell you my _____
9	to be in favour of sth.	If I support a suggestion then I am _____ of it
10	to be opposed to sth.	If I do not support a suggestion then I am _____ to it.

Class - 6A

	Unit 4 – Making a Difference	
Number	Vocabulary Item	Test Sentence
1	to donate (money to)	If you give money to charity you _____ charity.
2	to raise money/fundraise	If you collect money for a good cause then you _____ for a good cause.
3	drought	If it does not rain for a long time in an area then the area is affected by _____
4	siblings	My brothers and sisters are my _____
5	disobedience	The act of not doing what you are told to do (or misbehaving) is called _____
6	to initiate	To begin something is to _____ something.
7	to be targeted at	If I aim a product at a particular type of person I _____ that person.
8	likelihood	If something increases the probability of something else happening then it increases the _____ of it happening.
9	to evade paying taxes	If I do not pay the government what I owe them then I _____ taxes.
10	to spearhead a campaign	If a group leads a health campaign to raise public awareness (for example) then they _____ a campaign.

Week 4

Class - 7A

	Unit 4 - Health Issues	
Number	Vocabulary Item	Test Sentence
1	allergy	If I am sensivtive to something then I have an _____
2	fine dining	Eating in a very expensive restaurant is also known as _____
3	coronary disease	If I'm having trouble with my heart, then I could have _____
4	to enforce a ban	If you are the Police and you block someone from doing something that is now illegal, then you _____
5	to fulfil a need	If you require something and someone gives it to you, then they _____ your _____
6	stubborn	If I firmly refuse to do something you tell me to do, even though it might be good for my health, I am _____
7	to execute a task	If you do something, or carry it out, then you _____
8	impairment	If you are unable to do something physically or mentaly then you have an _____
9	physical disability	If you are unable to do something physically then you have a _____
10	to get sth. off one's chest	If you confess a secret to someone which has been weighing heavily on your mind then you _____

Class - 6A

	Unit 3 - The Blue Planet	
Number	Vocabulary Item	Test Sentence
1	biodegradable	If something can be broken down by natural processes in nature then it is _____
2	to cause damage to	Natural disasters like floods and hurricanes tend to _____ to houses in an area.
3	renewable	Hydro, wind, and solar energy are all sources of _____ energy.
4	emissions	Gases released into the atmosphere from automoiles or from industry are known as _____
5	to be moved to tears	When something is so emotional that it makes me cry then I am _____
6	abbreviation	UN is an _____ for United Nations.
7	carbon footprint	The amount of CO2 that are released into the atmosphere as a result of your activities is known as your _____
8	to account for	If cars are responsible for a large part of the CO2 emissions in a country then they _____ for the CO2.
9	to tackle	If we all group together to deal with a problem then we all _____ it together.
10	sustainable	If an activity can be continued without damaging the environment then it is _____

Delayed post-test memory test with correct answers

Details of the two final delayed post-test memory tests administered during the vocabulary experiment are given below.

Class - 7A

	DPT MEMORY TEST	
Number	Vocabulary Item	Question
1	moderate	If my views are reasonable and commonplace then I have _____ views.
2	clergyman	A man of the church is a _____
3	reluctant	If you are unwilling to do something you are _____
4	notorious	If somebody is famou, but not for doing something good then they are _____
5	elaborate	If something is complex and detailed then it is _____
6	superimposed	If a picture is layered on top of another so that you can still see both of them, then it has been _____
7	to heap praise	If you compliment, congratulate, or express admiration for somebody then you _____ on them.
8	beyond sb.'s control	If somebody cannot command authority over something it is said to be _____
9	eccentric belief system	If you believe in really strange things that some people might say are quite crazy then you could say you had an _____
10	to collaborate with sb.	If you cooperate with somebody you are said to have _____
11	to be convinced about/of sth	If I am sure about my own opinion then I am _____ it.
12	to have your doubts about sth	If I do not think that a politician is trustworthy then I _____ them.
13	to branch out	If a company expands its range and begins offering more products then it _____ out.
14	if you ask me	If I want to emphasise that something is my personal opinion then I would say, "if _____ me …"
15	quirky	If your behaviour is peculiar or unusual then you are _____
16	to mess with sb./sth.	If somebody is in a really bad mood and you make them feel frustrated or upset then you _____
17	to complement each other/to	If you and a friend are simply a great team together then you _____
18	left/right wing	If your views are extreme, at one or the other end of a political spectrum then you are either _____ or _____ wing.

DPT MEMORY TEST

Number	Vocabulary Item	Question
1	passionate	If I am very enthusiastic about something then you could say I was _____ about it.
2	to dedicate sth. to sb.	If a state builds a statue of someone then they _____ the statue to them.
3	workload	The amount of work you have to do is known as your _____
4	to be engaged in	To participate in a fight with somebody is to be _____ a fight with them.
5	to be bombarded with	If people keep asking you questions then you are being _____ questions
6	fundraising/raising money	If I collect money for charity then I have been _____
7	unemployable	If I am unfortunately not able to do anything you require of me so that you are unable to give me a job or find work for me then I am _____
8	to evade paying taxes	If I do not pay the government what I owe them then I _____ taxes.
9	far-reaching consequences	If the resulting damage of a flood has caused many and varied problems then we could say the flood had had _____
10	to dedicate oneself to	To commit youself to sombody or to a cause is to _____ somebody/something.
11	to spearhead a campaign	If a group leads a health campaign to raise public awareness (for example) then they _____ a campaign.
12	to owe	If you are in debt to the bank then you _____ the bank money.
13	to be flattered	If someone is very kind to you or praises you, then you could say that you are _____
14	precision	If the darts player hits the bullseye with perfection then he/she threw the dart with absolute _____
15	to contribute	If you do your bit for society you _____ to society.
16	to be targeted at	If I aim a product at a particular type of person I _____ that person.
17	to excel in	If you are brilliant at something then you _____ in it
18	to be caught in a dilemma	If I have a problem choosing between two options then I am _____

Raw quantitative data – MTM and DPT vocabulary tests

Details of all scores on MTM and DPT tests achieved by the 44 participants, along with Memrise engagement data are given below.

Colour key

▋	= Participant answered questionnaire
▋	= Participant was absent on day of test
▋	= Group 2 participant did not engage with Memrise during learning phase
▋	= Group 2 participant fully engaged with Memrise during 4-week experimental period
▋	= Worst results discounted in the control group to balance participants in different conditions

Vocabulary Tests – Raw Data

			Pre-Test		Medium-Term Tests									
					Week 1		Week 2		Week 3		Week 4			
	Class	ID	2.23	2.20	Test	Memrise	Test	Memrise	Test	Memrise	Test	Memrise	Average	DPT Test
Control Group	7A	6	1		10		10		10		7		9.3	7
		21	1		9		10		9		5.5		8.4	11
		8	1.5		7		8		8		4		6.8	6
		20	1.5		10		10		9		5.5		8.6	14
		4	2		9		6		6		2		5.8	9
		17	2.5		9		3				3		5.0	5
		5	2.5		9		10		9		10		9.5	7.5
		3	3.5		1		6		3		1.5		2.9	1
		23	3.5		4		5.5		4		2.5		4.0	3
		9	3.5		3		5		3		4		3.8	5
		13	3.5		7		4.5		2				4.5	
	6A	33	1		5.5		10		10		6		7.9	12.5
		39	1		7		5		9		4.5		6.4	11.5
		32	1.5		2.5		5		9		7.5		6.0	11
		26	2		4		10		10		3.5		6.9	7.5
		45	2		8		6.5		10		7		7.9	13
		2	2		7		5		10		6.5		7.1	13
		36	2		8		9.5		6		3.5		6.8	10
		29	2.5		9		6		10				8.3	
		42	3		7.5		7		9		5.5		7.3	10
		40	3		5		7.5		9		3.5		6.3	11
		34	3		9		7		7		6		7.3	13
Experimental Group	7A	11		1	5	14480	6	3941	4	6085	2	0	4.3	7
		19		1.5	6	8814	4	21104		0	8	15398	6.0	5
		16		1.5	8	1570		11341	3	12805	5	0	5.3	3
		10		1.5	6	3342	2	0	5	60585	6	0	4.8	9
		14		1.5	3	5936	3	12030	1	1087	3.5	0	2.6	2
		22		2	9	9444	9	16950	10	11383	8.5	0	9.1	8
		18		2.5	6	10546	0	0	1	0	0.5	0	1.9	2
		1		2.5	9	7124	10	2050	9	52207	10	12505	9.5	10
		12		3	9	5653	2.5	922	4	4733	1	0	4.1	3
		15		3.5	9	24094	10	4813	9	31281	10	12410	9.5	6.5
		7		4	7	11907	7	9024	4	2000		0	6.0	
	6A	25		1	8	5467	6	20770	10	12500	10	75306	8.5	18
		24		1	6	0	7	17172		0	5	0	6.0	12
		35		1.5	8	23530	6.5	39961		4035	7	35169	7.2	12
		28		2	8	692	5	5645	7	0	1	0	5.3	8.5
		43		2	4	150		19095	7	0	2.5	0	4.5	6
		31		2	4	0	1.5	1451	7	0	0.5	0	3.3	5
		37		2.5	7.5	3456	5	30624	10	9173	9.5	61641	8.0	17
		30		2.5	9	16472	10	16811	10	7865	7	71930	9.0	16
		41		3	7	19765	7	8782	10	20389	10	66708	8.5	16
		27		3.5	8	3468	10	43455		4049	2.5	26037	6.8	10
		38		3	8	25	3	31958	8	349		0	6.3	

Results adjusted for minimal engagement

Group	Class	ID	Week 1 Test	Week 2 Test	Week 3 Test	Week 4 Test	Average	DPT Test
Control Group	7A	6	10	10	10	7	9.3	
		21	9	10	9		9.3	11
		8	7	8	8		7.7	
		20	10	10	9	5.5	8.6	14
		4	9	6			7.5	
		17	9				9.0	
		5	9	10	9	10	9.5	
		3		6			6.0	
		23	4	5.5			4.8	
		9	3					
		13	7				7.0	
	6A	33	5.5	10	10	6	7.9	12.5
		39	7	5	9		7.0	11.5
		32			9	7.5	8.3	11
		26	4	10	10		8.0	
		2	8	6.5	10	7	7.9	13
		44	7	5	10	6.5	7.1	13
		36	8	9.5			8.8	10
		29	9	6	10		8.3	
		42	7.5	7		5.5	7.3	10
		40	5	7.5	9	3.5	6.3	11
		34	9	7	7	6	7.3	13
Experimental Group	7A	11	5	6	4		5.0	7
		19	6	4		8	6.0	
		16	8		3		5.5	
		10	6		5		5.5	
		14	3	3	1		2.3	2
		22	9	9	10		9.3	8
		18	6					
		1	9	10	9	10	9.5	10
		12	9	2.5	4		5.2	
		15	9	10	9	10	9.5	6.5
		7	7	7	4		6.0	
	6A	25	8	6	10	10	8.5	18
		24		7			7.0	
		35	8	6.5		7	7.2	12
		28	8	5			6.5	
		43	4				4.0	
		31		1.5			1.5	
		37	7.5	5	10	9.5	8.0	17
		30	9	10	10	7	9.0	16
		41	7	7	10	10	8.5	16
		27	8	10		2.5	6.8	10
		38	8	3	8		6.3	

Results adjusted for full engagement

| | Class | ID | Medium-Term Tests | | | | Average | DPT |
			Week 1 Test	Week 2 Test	Week 3 Test	Week 4 Test		Test
Control Group	7A	21	9	10	9	5.5	8.4	11
		20	10	10	9	5.5	8.6	14
	6A	33	5.5	10	10	6	7.9	12.5
		39	7	5	9	4.5	6.4	11.5
		2	8	6.5	10	7	7.9	13
		44	7	5	10	6.5	7.1	13
		40	5	7.5		3.5	5.3	11
		34	9	7		6	7.3	13
Experimental Group	7A	1	9	10	9	10	9.5	10
		15	9	10	9	10	9.5	6.5
	6A	25	8	6	10	10	8.5	18
		35	8	6.5		7	7.2	12
		37	7.5	5	10	9.5	8.0	17
		30	9	10	10	7	9.0	16
		41	7	7	10	10	8.5	16
		27	8	10		2.5	6.8	10

Participant questionnaire – questions and structure

Full details of the online questionnaire administered using Google Forms are given below, followed by a table summary of all participant responses that were collected.

Questionnaire - Structure
* Required

1. Please select your group: * *Mark only one oval.*

    ⬭   I am a student and was part of the experimental group (group 2/Memrise group) I

    ⬭   am a student and was in the control group (group 1)   *Skip to question 15.*

    ⬭

    ⬭   I teach the 7A in English

 I teach the 6A in English

Experimental group

2. Please enter your Unique-ID (see original email in your BRG14 email account) *

    _____

3. Which of the following methods do you normally use to study English vocabulary?

(Multiple answers possible) * *Check all that apply.*

    ☐   I learn from the coursebook

    ☐

    ☐   I make my own notes/flashcards

    ☐   I   _____   learn   using   a   favourite

mobile/web application Other:

4. If you normally use a mobile/web application, please specify which one:

    _____

5. How often do you use mobile applications to help you with your vocabulary learning (in any language)? * *Mark only one oval.*

    1   2   3   4   5

Often ◯ ◯ ◯ ◯ ◯ Never

6. Did using the Memrise App help you to learn the vocabulary more quickly or efficiently than the method you normally use? * *Mark only one oval.*

    1   2   3   4   5

Yes, it helped a lot ◯ ◯ ◯ ◯ ◯ No, it didn't help at all

7 For each test, how often did you study the vocabulary? * *Mark only one oval.*

    1   2   3   4   5

I studied regularly ◯ ◯ ◯ ◯ ◯ I studied the vocabulary once

8. For each test, how much time did you spend studying? * *Mark only one oval.*

◯ Less than 30 mins

◯ Between 30 minutes and 1 hour

◯ Between 1 and 2 hours

◯ Between 2 and 3 hours

More than 3 hours

9. When did you study the vocabulary? (Multiple answers possible) * *Check all that apply.*

☐ At school

☐ On the way to or from school

☐ Out of school, during times I usually study

☐ _____ Out of school, during times I wouldn't normally study Other:

10. What did you like most, or find most useful about using Memrise? *

_____

_____

_____

_____

_____

11. What did you not like about using the Memrise App? *

_____

_____

_____

_____

_____

12. If you could, how would you improve Memrise? Are there any features you would add? Would you change anything? *

_____

_____

_____

_____

_____

13 Would you like to see teachers include the use of mobile technologies (not necessarily Memrise) in your English lessons, or as part of your English courses? * *Mark only one oval.*

◯ Yes

◯ No

◯ _____ Maybe

 Other:

14. If there are any relevant comments, thoughts, or opinions that you would like to share, please feel free to share them below

Stop filling out this form.

Control Group

15. Please enter your Unique-ID (see original email in your BRG14 email account) *

_____

16. Which of the following methods do you normally use to study English vocabulary?

(Multiple answers possible) * _Check all that apply._

☐ I learn from the coursebook

☐ I make my own notes/flashcards

☐ I _____ learn using a favourite

mobile/web application Other:

17. If you normally use a mobile/web application, please specify which one:

_____

18. How often do you use mobile applications to help you with your vocabulary learning

(in any language)? * _Mark only one oval._

      1   2   3   4   5

Often ◯ ◯ ◯ ◯ ◯ Never

19 For each test, how often did you study the vocabulary? * _Mark only one oval._

      1   2   3   4   5

I studied regularly ◯ ◯ ◯ ◯ ◯ I studied the vocabulary once

20. For each test, how much time did you spend studying? * *Mark only one oval.*

   ◯   Less than 30 mins

   ◯

   ◯   Between 30 minutes and 1 hour

   ◯   Between 1 and 2 hours

   ◯

   Between 2 and 3 hours

More than 3 hours

21. When did you study the vocabulary? (Multiple answers possible) * *Check all that apply.*

   ☐   At school

   ☐

   On the way to or from school

   ☐

   Out of school, during times I usually study

   ☐   _____

                          Out of school, during times I

wouldn't normally study Other:

22. Would you like to see teachers include the use of mobile technologies (not necessarily

Memrise) in your English lessons, or as part of your English courses? * *Mark only one oval.*

   ◯   Yes

   ◯

   ◯   No

   ◯   _____   Maybe

Other:

23. If there are any relevant comments, thoughts, or opinions that you would like to share, please feel free to share them below

_____

_____

_____

_____

_____

Answers given by participants
Questions 1-4

<table>
<tr><td colspan="8">Participant Questionnaire – Raw Data</td></tr>
<tr><td colspan="3"></td><td colspan="5">Questions 1-4</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Class</td><td>ID</td><td colspan="2">Pre-Test Learning Behaviour</td><td>Prefered Application</td><td>App Use</td><td>Frequency of Study</td></tr>
</table>

Group	Class	ID	Pre-Test Learning Behaviour	Prefered Application	App Use	Frequency of Study
Group 1	7A	21	I learn from the coursebook		1	5
		8	I make my own notes/flashcards	Quizlet	1	3
		17	I learn using a favourite mobile/web application	Quizlet	1	3
		13	I learn from the coursebook		5	4
	6A	33	I learn from the coursebook		4	3
		26	I learn from the coursebook		3	4
		44	I learn using a favourite mobile/web application	Quizlet	1	3
		40	I make my own notes/flashcards		5	3
		34	I learn using a favourite mobile/web application	Quizlet	1	3
Group 2	7A	11	I learn using a favourite mobile/web application	Quizlet	1	5
		10	I learn using a favourite mobile/web application	quizlet, but now also memrise, i like to mix it	1	2
		22	I learn from the coursebook;I learn using a favourite mobile/web application	Quizlet	1	4
		7	I learn from the coursebook		4	4
	6A	38	I learn using a favourite mobile/web application	Quizlet	3	5

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Questions 5-7 and question 12

	Class	ID	5 Time Spent Studying	6 Time and Place of Study	7 Integrate MALL?	12 Closing Comments
					Questions 5-7 + 12	
Group 1	7A	21	Less than 30 mins	At school	Yes	I really enjoyed not knowing if the other group was winning and then clicking on the spreadsheet on Monday to see the graphs and find out how my group had done
		8	Between 30 minutes and 1 hour	At school;On the way to or from school;Out of school, during times I usually study;Out of school, during	Maybe	
		17	Between 30 minutes and 1 hour	Out of school, during times I wouldn't normally study	Yes	
		13	Less than 30 mins	At school;On the way to or from school;Out of school, during times I usually study	Maybe	
	6A	33	Less than 30 mins	At school;On the way to or from school;Out of school, during times I usually study	No	
		26	Less than 30 mins	At school	Maybe	
		44	Less than 30 mins	At school;Out of school, during times I usually study;Out of school, during times I wouldn't normally study	Yes	It wasn't enough to know the German translation of a word but rather the meaning and where one can use that word. I thought that was very good an definetely helped me remember the vocabulary long - term.
		40	Less than 30 mins	On the way to or from school;Out of school, during times I wouldn't normally study	Yes	
		34	Less than 30 mins	At school;Out of school, during times I usually study	Yes	
Group 2	7A	11	Less than 30 mins	At school;Out of school, during times I usually study	Yes	
		10	Between 1 and 2 hours	At school;Out of school, during times I usually study;Out of school, during times I wouldn't normally study	Yes, but more to ease the vocabulary learning at home and not in the lesson itself	
		22	Between 30 minutes and 1 hour	At school;On the way to or from school;Out of school, during times I usually study	Yes	Was a fun experiment :). I enjoyed finding out the results every Monday.
		7	Less than 30 mins	At school;On the way to or from school;Out of school, during times I usually study	Yes	thanks for the haribos
	6A	38	Between 30 minutes and 1 hour	On the way to or from school;Out of school, during times I wouldn't normally study	Yes	I like learning with my mobile, but I didn't find Memrise as good as other apps

Memrise-specific questions 8-11

	Class	ID	Questions 8-11			
			8	9	10	11
			Did Memrise Help?	Like?	Dislike?	Improvments
Group 2	7A	11	**4**	nothing really	that it takes you hours to learn 5 words, escpecially when it's a word that you are already a bit familiar with, then it's quite frustrating to spent ages on repeating it	change it to quizlet; find a way that each student can study in his own pace and not be held back or rushed through the vocabulary
		10	**2**	I really liked that you learn about five words, and then the next ones. Because with Quizlet you lern every word once and are then asked to remember 40 words, which takes a very long	At one point, when I have already learned many words, it wasn't possible to repeat just the new words.	I would add the option to repeat just the new words, and the option to chose some words to repeat, because I felt like the difficult words weren't repeated often enough. Oh, and really important, I would add a button to say that I meant the right thing (Quizlet has that) even though I wrote the wrong one, because that happens really quick, when you work with a laptop but it is very nerve-wracking it you now how a word is spelled, but just touched one wrong letter.
		22	**4**	The app/system has a lot of potential but it doesnÂ´t seem, like it was completely thought through. The animations with the flower growing is nice though.	It just takes sooooo long. And I want to decide myself if and when I revise, the chapters should be completely apart from each other.	Definitely split the chapters, improve the audio and picture system and somehow make, that it doesnÂ´t take sooo long to make the flower open up.
		7	**1**	the flower	the audio option and the sentence-building	take the sentence-building option away
	6A	38	**4**	I don't normally like studying with the book, so the app made it kind of fun to learn with the flower	It took way too long to learn the vocabulary because it kept showing me old words.	Make it take less time

Abstract - English

Mobile-assisted language learning, or MALL, is a comparatively young area of language research that has been attracting increased research attention in recent years as the trend towards the ever-increasing functionality of mobile technologies continues to exert its influence on the world of education. Reduced cost, increased functionality, and ubiquitous accessibility are all factors that combine to suggest that mobile smartphones can now be regarded as valuable language learning tools that should be taken seriously in the field of education. However, despite the possibility and promise of harnessing existing and opening up new pedagogical paradigms in the teaching and learning of languages, the question of the extent to which MALL applications can play a part in language education models of the future remains open.

With a new generation of digital natives entering today's school system, who have now grown up with and enjoy unlimited access to advanced mobile technology, the opportunity to utilise and leverage the possibilities offered by mobile technology in the EFL classroom as part of standard EFL courses, especially in the learning of EFL vocabulary, has never been greater. However, studies show that Austria is lagging behind in terms of the uptake and use of digital technology in the classroom.

This research paper examined the efficacy of a MALL vocabulary learning application (Memrise) as a complement to a school-level EFL program for German-speaking students in an Austrian high-school context. The study aimed to replicate the results of previous MALL research that has reported significant learning outcomes when comparing MALL vocabulary learning interventions with traditional offline, paper-based learning methods, and in addition asses learner behaviour and attitudes towards MALL applications. The study utilised a mixed methods design and compared an experimental group who learned selected vocabulary items using Memrise, with a control group who utilised only offline paper-based methods. Objective measures of learning outcomes were obtained using specially designed vocabulary tests which were administered in both medium-term and delayed post-test vocabulary tests. Qualitative and quantitative data on participant learning behaviour and attitudes were then collected through the administration of a post-test questionnaire.

The area of MALL seems set to become increasingly important in the future of language education. This research paper aims to add to the ongoing discussion.

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Abstract - Deutsch

Das Mobile-assisted Language Learning (MALL) ist ein vergleichsweise junges Gebiet der Sprachforschung, das in den letzten Jahren zunehmend Aufmerksamkeit in der Forschung auf sich gezogen hat, da sich der Trend zu immer größeren Funktionalität mobiler Technologien auch in der Bildungswelt zeigt. Reduzierte Kosten, verbesserte Funktionalität und allgegenwärtige Zugänglichkeit sind allesamt Faktoren, die zusammen darauf hindeuten, dass Smartphones als wertvolle Werkzeuge zum Erlernen von Sprachen angesehen werden können, die im Bildungsbereich ernst genommen werden sollten. Trotz der Möglichkeit und des Versprechens, bestehende und neue pädagogische Paradigmen beim Lehren und Lernen von Sprachen zu nutzen, bleibt die Frage offen, inwieweit MALL-Anwendungen in Sprachbildungsmodellen der Zukunft eine Rolle spielen können.

Mit einer neuen Generation von Digital Natives im Schulsystem, die mit fortschrittlicher Mobiltechnologie aufgewachsen ist und selbst und uneingeschränkt Zugang zu dieser fortgeschrittenen Mobiltechnologie hat, bietet sich die einzigartige Gelegenheit, diese neuen durch Mobiltechnologie gewonnenen Möglichkeiten im EFL-Klassenzimmer im Rahmen von Standard-EFL-Kursen einzusetzen, insbesondere beim Erlernen des EFL-Vokabulars. Studien zeigen jedoch, dass Österreich hinsichtlich der Akzeptanz und Nutzung digitaler Technologien im Klassenzimmer hinterherhinkt.

Die vorliegende, im Rahmen der Diplomarbeit durchgeführte Studie untersuchte die Wirksamkeit einer MALL-Vokabellernanwendung (Memrise) als Ergänzung zu einem EFL-Programm auf Schulebene für deutschsprachige Schüler in einem österreichischen High-School-Kontext. Die Studie zielte darauf ab, Ergebnisse früherer MALL-Studien zu wiederholen, die signifikante Lernergebnisse beim Vergleich von MALL-Vokabellerninterventionen mit traditionellen Offline-Lernmethoden auf Papier zeigten, sowie das Verhalten und die Einstellung der Lernenden gegenüber MALL-Anwendungen zu bewerten. Bei der Studie wurde ein Mixed-Methods-Ansatz eingesetzt, wobei eine experimentelle Gruppe, die ausgewählte Vokabeln mit Memrise lernte, mit einer Kontrollgruppe, die nur Offline-Methoden auf Papierbasis verwendete, miteinander verglichen wurden. Objektive Messungen der Lernergebnisse wurden unter Verwendung speziell entwickelter Vokabeltests erhalten, die sowohl anhand mittelfristigen als auch einem delayed post-test Vokabeltests durchgeführt wurden. Qualitative und quantitative Daten zum Lernverhalten und zur Einstellung der Teilnehmer wurden anschließend mittels eines Fragebogens nach dem Test gesammelt.

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Der Bereich MALL scheint in der Zukunft des Sprachunterrichts zunehmend an Bedeutung zu gewinnen. Die vorliegende Arbeit soll die laufende Diskussion ergänzen.