THE EFFECTS OF USING A THEORY- BASED MOBILE APPLICATION ON EFL LEARNERS' VOCABULARY LEARNING AND RETENTION

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in English Language Studies

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ผลของการใช้โมบายแอพพลิเคชั่นเชิงทฤษฎีต่อการเรียนคำศัพท์และความคงไว้ในการจำคำศัพท์ของผู้เรียนที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศ

นายซิงซิง หม่า

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรดุษฎีบัณฑิต
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งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของการใช้โมบายแอพพลิเคชั่นเชิงทฤษฎีต่อการเรียนคำศัพท์และความคงไว้ในการจำคำศัพท์ของผู้เรียนที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศ นอกจากนี้ยังมุ่งศึกษาการรับรู้ของนักเรียนที่มีต่อแอพพลิเคชั่นดังกล่าวอีกด้วย ในการศึกษาครั้งนี้ทำการวิจัยที่มหาวิทยาลัยที่ประเทศจีน โดยแบ่งนักศึกษาชั้นปีที่หนึ่งออกเป็นกลุ่มทดลองจำนวน 56 คน เรียนคำศัพท์ 80 คำ ผ่านทางแอพพลิเคชั่นเป็นเวลา 8 สัปดาห์ และ กลุ่มควบคุมจำนวน 58 คน เรียนคำศัพท์ชุดเดียวกันกับกลุ่มทดลองแต่เรียนจากกระดาษรายการคำศัพท์ข้อมูล ที่ได้นำมาวิเคราะห์ด้วยวิธีการเปรียบเทียบค่าเฉลี่ยกลุ่มตัวอย่างอิสระ (independent-samples t-test) และการเปรียบเทียบของกลุ่มตัวอย่างไม่อิสระ (paired-samples t-test) ผลการวิจัยพบว่าการเรียนรู้คำศัพท์ก่อนและหลังเรียนของนักศึกษากลุ่มทดลองที่เรียนคำศัพท์จากแอพพลิเคชั่นเพิ่มสูงขึ้นอย่างมีนัยสำคัญทางสถิติที่ระดับ .0 นอกจากนี้กลุ่มทดลองมีคะแนนสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติที่ระดับ .0 แสดงให้เห็นว่าโมบายแอพพลิเคชั่นสามารถเป็นเครื่องมือที่มีประสิทธิภาพในการเพิ่มการเรียนรู้คำศัพท์ของนักศึกษาได้ดีกว่าการใช้กระดาษรายการคำศัพท์ นอกจากนี้ผลการวิจัยในส่วนของการคงไว้ในการจำคำศัพท์ไม่พบความคงไว้ของการจำคำศัพท์ลดลงของกลุ่มที่ใช้โมบายแอพพลิเคชั่น และยังมีความคงไว้ในการจำคำศัพท์มากกว่ากลุ่มที่ใช้กระดาษรายการคำศัพท์ แสดงให้เห็นว่าโมบายแอพพลิเคชั่นช่วยให้นักศึกษามีความคงไว้ของคำศัพท์มากกว่านักศึกษาที่เรียนคำศัพท์จากการใช้กระดาษรายการคำศัพท์ ผลของแบบสอบถาม การสัมภาษณ์ และจากบันทึกการเรียนของนักศึกษาแสดงให้เห็นว่านักศึกษาส่วนใหญ่มีทัศนคติที่ดีต่อการเรียนคำศัพท์โดยใช้โมบายแอพพลิเคชั่น ดังนั้นการใช้โมบายแอพพลิเคชั่นจึงเป็นวิธีที่ช่วยในการเรียนรู้คำศัพท์และคงไว้ของการจำคำศัพท์ได้มากกว่าการใช้วิธีเรียนโดยยึดหลักรายการคำศัพท์

สาขาวิชาภาษาต่างประเทศ
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ลายมือชื่อนักศึกษา XingXing Ma
ลายมือชื่ออาจารย์ที่ปรึกษา

XINGXING MA : THE EFFECTS OF USING A THEORY- BASED MOBILE APPLICATION ON EFL LEARNERS' VOCABULARY LEARNING AND RETENTION. THESIS ADVISOR : BUTSAKORN YODKAMLUE, Ph.D., 258 PP.

MOBILE APP/ CHINA/ EFL UNIVERSITY STUDENTS/ VOCABULARY LEARNING/ VOCABULARY RETENTION

The present study aims to examine the effects of using a theory-based mobile application on EFL university students' vocabulary learning and retention. The students' perceptions of the app are also explored. During the eight-week treatment, conducted at a university in China, one intact class with 56 first-year students using the application to learn 80 target words was named as the experimental group, while a control group of 58 students used a paper-based wordlist to learn the same target words. The data was analyzed by an independent-samples t-test and a paired-samples t-test. The results showed that there was a statistically significant difference at .0 level between pre-test and post-test on vocabulary learning achievements of the experimental group. The results from the independent-samples t-test also revealed that the experimental group significantly outperformed the control one in vocabulary learning achievements at .0 level. Thus, indicating that mobile application could be an effective learning tool to improve students' vocabulary knowledge. Furthermore, the retention scores within the experimental group did not show significant decrease whereas the control one did, suggesting that the mobile application had positive effects on vocabulary retention than the paper-based wordlist. Additionally, the data obtained from the students' questionnaires, interviews, and diaries highlighted that the students

held positive attitudes towards the mobile application. Accordingly, the mobile application offered a better approach in enhancing vocabulary learning and retention than the wordlist-based one.

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LIST OF ABBREVIATIONS

L1	First language
L2	Second language
CET4	College English Test Band-4
TEM4	Test for English majors Band-4
ESL	English as a Second Language
EFL	English as a Foreign Language
CALL	Computer Assisted Language Learning
MALL	Mobile-assisted Language Learning
IOC.	Item-Objective Congruence
SPSS	Statistical Package for the Social Sciences
EG	Experimental Group
CG	Control Group
RQ	Research Question

CHAPTER 1

INTRODUCTION

An introduction to the thesis is presented in this chapter. Firstly, the background of the present study is introduced. Then, a statement of the problem, purposes of the study, research questions, significance of the study, the scope of the study, limitations of the study, and the definitions of the key terms are given, respectively. Lastly, this chapter concludes with a summary.

1.1 Background of the Study

1.1.1 The Importance of Vocabulary in Language Learning

Vocabulary is essential for language learning because language learners cannot understand others or express their ideas without vocabulary. Wilkins (1972) points out that "While without grammar very little can be conveyed, without vocabulary nothing can be conveyed" (pp. 111-112). This viewpoint reflects the great importance of vocabulary in language communication. Based on McCarthy (1990), without vocabualry to express various kinds of ideas and meanings, communications with a second language can not be fulfilled in a meaningful way even if learners have mastered L2 grammar and pronunciations well. Besides, Laufer and Hulstijn (1998) claim that learners should learn a lot of second language vocabulary before learning a second language, and vocabulary learning should continue throughout the entire process of second language learning. Similarly, Gass (1999) maintains that to learn a foreign

language is to learn its vocabulary. Therefore, it is not difficult to find that learning vocabulary is central for any language learning.

Research findings have shown that improvement in vocabulary is likely to enhance learners' performances in listening (Afshari & Tavakoli, 2017; Wang & Wu, 2011), reading (Li, 2003; Liu, 2006; Qian, 1999, 2002; Staehr, 2008, 2009; Shen, 2011, 2013; Song, 2014; Zhang & Qiu, 2006), speaking (Liu, 2016; Shi, 2012), writing (Hou, 2016; Milton, Wade, & Hopkins, 2010; Wu, 2010; Zhang, 2012), and language proficiency (Huang, 2003; Liu, 2016). Thus, vocabulary can make a significant contribution to the test scores of the four skills and language proficiency. Afshari and Tavakoli (2017) revealed that test-takers' vocabulary knowledge could explain 57 % of TOEFL listening scores. Another study by Wang (2010) revealed that students' vocabulary knowledge has a strong correlation with their reading scores in the Test for English Majors Band 4 (TEM4) of China, with the correlation coefficient being 0.853. Similarly, Shi (2012) found that there also existed a significantly positive correlation between test-takers' vocabulary knowledge and their speaking scores of IELTS, with the correlation coefficient being 0.863. Moreover, Hou (2016) highlighted that vocabulary knowledge could account for 81.3 % of writing scores in writing tests. Furthermore, according to Liu (2016), 56% of the total score in the CET4 (College English Test Band 4) of China could be predicted from students' vocabulary knowledge. The studies above indicate that the more vocabulary the students know, the better the performances they can achieve in the four language skills as well as in language proficiency. Thus, given the importance of vocabulary in language learning and tests, improving learners' vocabulary is essential.

1.1.2 Vocabulary Retention

Retention refers to the ability to keep something continuously in mind. Vocabulary retention is defined by Maryam and Ahmad (2017) as the ability to remember or retain vocabulary in one's mind. Vocabulary retention, vocabulary memory, and vocabulary maintenance are interchangeable in the present study. Also, it has been claimed that memory can be divided into three types: sensory memory (lasting from milliseconds to a few seconds), short-term memory (lasting from several seconds to a few minutes), and long-term memory (lasting forever), concerning the amount of time the memory lasting (Zhang, 2004).

On the one hand, the primary purpose of learners' learning vocabulary is for keeping the learnt words in their minds. On the other hand, it has been pointed out that what has been learnt is rapidly forgotten in terms of the forgetting curve (Wozniak, 1999). As cited by Wozniak (1999), Ebbinghaus (1885) found that information loss is exponential with time going on. Additionally, the forgetting curve illustrates that memory decay starts immediately and then slows down over the next six days. After Ebbinghaus' (1885) study, much research on information retention and rapid forgetting was conducted (Bahrick, 1992; Conway, Cohen, & Stanhope, 1992; Farjami & Aidinlou, 2013; Thalheimer, 2010). Bahrick (1992) highlighted the fact that, in the first six days, learners' brains would lose 20% of what they just learnt exceptionally rapidly. Conway et al. (1992) got an almost the same conclusion to that of Bahrick (1992). However, Thalheimer (2010) believes that forgetting information varies significantly relying upon the teaching approaches that were used for the beginning, the times of review, and the information processing level initially. It was also found that those students employing

the least effective ways would lose 21.7% of the learnt (Thalheimer, 2010). Thus, the studies above show that teaching methods might affect information retention negatively.

For vocabulary retention, Farjami and Aidinlou (2013) stated that a very challenging obstacle for foreign language learners was the necessity of mastering lots of words and that they forgot the acquired vocabulary very quickly. It was also revealed that it is really difficult to maintain many EFL vocabulary items for a long term (Orozco, 2019). To find ways of preventing learners from forgetting words and helping them retain the words in long-term memory, the following studies have been conducted: Icht and Mama, 2019; Immordino-Yang and Damasio, 2007; Karousou and Nerantzaki, 2020; Koester, 2015; MacLeod et al., 2010; McBride and Dosher, 2002; Ozubko and MacLeod, 2010; Senkfor et al., 2008; Wammes et al., 2016. Additionally, various ways to improve vocabulary retention have been identified, which are rehearsal (Atkinson & Shiffrin, 1968; Rundus, 1971), elaboration (Anderson & Reder, 1979; Rinne et al., 2011), enactment (Mohr et al., 1989; Senkfor et al., 2008), oral production (Icht & Mama, 2019; Karousou & Nerantzaki, 2020; MacLeod et al., 2010; Ozubko & MacLeod, 2010), emotional arousal (Cahill & McGaugh, 1995; Immordino-Yang & Damasio, 2007), and pictorial representation (Koester, 2015; McBride & Dosher, 2002; Wammes et al., 2016).

1.1.3 Vocabulary Teaching and Learning in the Chinese Context

In China, students spend much time and effort on learning wordlists throughout their English studies. Zhang (2008) found that reciting wordlists was ranked the most frequent vocabulary learning strategy to retain vocabulary among Chinese university students, which is also consistent with Schmitt's (1997) research. This most frequent vocabulary learning strategy may have been greatly influenced by the

traditional teaching methods used in the Chinese EFL classroom. Wang (2014) demonstrated that wordlist-based teaching was the most typical teaching method from Grade 3 of elementary school to higher education, leading to the habit of reciting wordlists among Chinese students.

There are some advantages of traditional wordlist-based teaching and learning. It was claimed that wordlist-based teaching could directly require learners to memorize the spelling, pronunciation, and words' meanings at a time (Carter, 1987; Clipperton, 1994; Nation, 1993). Also, Meara (1995) stated that wordlists played a key role at the first stage of learning a language. Furthermore, Zeng (2007) argued that reciting wordlists is an efficient method and of great importance in language learning: for one thing, there is a possibility that learners can master large amounts of words in a short time by using a wordlist; for another, wordlists meet learners' psychological needs for mastering many words.

However, there are also some disadvantages concerning wordlist-based teaching or learning. Gairns and Redman (1986) proved that using wordlists hinders vocabulary processing and thus they result in students losing a base for long-term retention. Later, Mondria et al. (1991) proposed that learners should refuse to use wordlists to memorize vocabulary, because they can confuse students and make them forget some items. Meanwhile, Gui (1991) pointed out that using wordlists for vocabulary learning and retention was in vain, for it treated the target words as if they had an equivalent meaning in Chinese which was not helpful in students' forming a semantic network. However, Oxford and Scarcella (1994) experimented and found that wordlists were helpful in vocabulary tests, but resulted in the vocabulary being

forgotten too quickly. Another study conducted by Ye (2016) showed that the traditional method of wordlist-based teaching in Chinese universities failed to help students retain new words or to have a significant influence on the efficiency of vocabulary learning.

1.1.4 Current Situation of the Research Site

The research site in the current study is located in Anshun University (ASU). It belongs to Anshun city in the Guizhou province of China, where 35 ethnic minority groups live in the same community. In ASU, there are 16 institutes and an affiliated senior high school. In detail, 57 majors are offered, 29 of which are in pedagogic specialities. In the 2019 academic year, 9, 308 full-time undergraduate students were enrolled in the university.

All non-English majors are compulsory for taking the College English course in the first two years of a four-year program. College English course is compulsory for non-English majors to attend. The number of teaching hours in College English 1 (CE1) is two hours a week for fourteen successive weeks within the first semester. Also, the objective of CE1 is facilitaing students' reading, listening, translating, speaking, and writing skills of university students. However, little attention is paid to vocabulary. Besides, according to a classroom survey by a researcher in 2018, 80% of the students complained that they had no choice but to learn words by reciting wordlists in the textbooks on their own.

Moreover, the pilot study in September of the 2018 academic year at ASU revealed that the average number of vocabulary items among non-English students was 2,300 words. The vocabulary size was far from the requirement of 4,500 words for passing CET4, which is the prerequisite for university non-English majors to obtain a bachelor's degree and then to find a job (Jiang, 2016). Unsurprisingly, the pass rate of

CET4 has stayed low, ranging from 4.11% to 5.8% in the past five years (2014-2018). This indicates the low vocabulary level among the university students at ASU. Therefore, the need to improve students' vocabulary knowledge has become an urgent issue which needs solving by the English teachers at ASU.

Lastly, "College English Curriculum Requirements" issued by the Ministry of Education (2007) in China emphasizes changing from teacher-centered to student-centered patterns with the use of modern technology. These changes are likely to break the barriers or the constraints of time and place to some extent which might improve the efficiency of English learning and facilitate more individualized learning.

To sum up, in the Chinese context, wordlist-based teaching and learning are widespread, and there are disadvantages as well as advantages. Combined with the current situation at ASU and the proposed changes in teaching methodology, it is needed urgently for continuing research into EFL vocabulary learning to broaden the theoretical understanding of vocabulary acquisition and in practice to explore new ways to improve the vocabulary learning and retention of Chinese EFL learners. Nowadays, with the rapid development of technology, one possible way to improve vocabulary learning is through Mobile-Assisted Language Learning (MALL).

1.1.5 MALL and Mobile-Assisted Vocabulary Learning

The term "MALL" has many definitions. MALL is referred to as any kind of learning that happens when one is movable, or learning that happens when he/she makes use of the chances provided by mobile technologies (O'Malley et al., 2003). In addition, Chinnery (2006) refers to MALL as language learning that is supported or enhanced by using a handheld mobile device. Subsequently, Kukulska-Hulme and

Shield (2008) pointed out that MALL distinguishes from CALL (computer-assisted language learning) in using portable facilities that create innovative learning types, putting an emphasis on the accessible spontaneity and interaction among various contexts. Based on the definitions above, in the present study, MALL is defined as the process of language learning, which is assisted or enhanced by mobile devices, mobile technologies, or learners' mobility.

The features of mobile devices that can result in educational benefits may explain the effectiveness of MALL on language learning: being portable, being interactive socially, being connective, and being individual (Klopfer, Squire, & Jenkins, 2002). In particular, portability means that mobile devices are easy to carry or to move. That is, one can carry his/her phone all the time in the pocket, and a PAD in ones' backpack, even in a handbag. Social interactivity means that mobile devices allow learners to communicate with other users or learners, offering them a chance to interact with each other. Connectivity indicates that mobile devices can be connected to the internet because most of them have a wireless function. The quality of connectivity makes learners able to obtain access to online learning materials anytime and anywhere. Lastly, individuality means that learners can study individually by using a mobile device.

Mobile-Assisted Vocabulary Learning

Research on MALL has indicated the effectiveness of using mobile devices in vocabulary learning. Mobile devices help increase learners' vocabulary achievements for their convenience (Basal et al., 2016), enjoyment (Bensalem, 2018), and flexibility (Jafari & Chalak, 2016). In addition, Osaki, Ochiai, Iso, and Aizawa

(2003) examined how three ways of learning modes: a paper dictionariy, an electronic dictionary, and without any dictionary affected secondary vocabulary acquisition. Results from delayed vocabulary tests suggested that learners with electronic dictionaries got higher scores than the counterparts with paper dictionaries and those who did not use dictionaries.

From a similar perspective, Lu (2008) inspected the effectiveness of SMS (short message service) on vocabulary lessons when they appear on the screen of mobile phones. Thirty high school students in Taiwan were involved in the program, and they were randomly distributed in the SMS group and a traditional paper group. Pre-test, post-test, and delayed tests were carried out in the experiment. Moreover, the results showed that both groups made some improvements. Nevertheless, "the students recognized more vocabulary during the post-test after reading the regular and brief SMS lessons than they did after reading the relatively more detailed print material" (Lu, 2008, p.515).

More recently, Basoglu and Akdemir (2010) compared MALL with traditional approaches to vocabulary learning in an attempt to examine which method worked better for learners. In their study, a mobile phone-based flashcard application (also app hereafter) was used by an experimental group for learning vocabulary while a printed flashcard was employed as a vocabulary learning tool by a control group. As a result, the flashcard app was more powerful in supporting vocabulary improvement than the printed flashcard. The findings also revealed that students found the flashcard app-based learning vocabulary helpful and entertaining.

Although the research found that students could learn vocabulary effectively or achieve more vocabulary via MALL, less encouraging and even negative results about the effectiveness of mobile devices on vocabulary learning do exist. Stockwell (2007) disclosed that using mobile phones to learn vocabulary was not so good as employing desktop computers. By comparing the effectiveness of the two techniques on vocabulary learning, few differences on learners' performances were seen. Moreover, Stockwell (2010) found that learners were not willing to use mobile phones for learning vocabulary, which was contrary to previous research. His explanation of the results might be high cost of accessing the internet, the small-sized keypad of a mobile device, and the display screen. Also, Okunbor and Retta (2008) carried out an experiment for a year to examine if using mobile phones could improve learners' learning. The results were that many students perceived mobile phones as ineffective in learning.

The effectiveness of MALL on vocabulary learning has been examined by some studies (e.g. Basal et al., 2016; Başoğlu & Akdemir, 2010; Bensalem, 2018; Jafari & Chalak, 2016; Lu, 2008; Osaki et al., 2003), while negative results concerning the role of MALL were identified in the research of other studies (Stockwell, 2007, 2010; Okunbor & Retta, 2008). Thus, further research is needed to be carried out to investigate the impacts of MALL on vocabulary learning.

To summarize, with regard to the importance of vocabulary, vocabulary retention, vocabulary teaching and learning in a Chinese context, and also the current situation of Anshun University, a detailed study of the use of a mobile application as a tool for EFL vocabulary learning as well as retention among Chinese university students is urgently needed to test its effectiveness.

1.2 Statement of the Problems

The English vocabulary of Chinese university students is currently at a low level. According to Zhang (2008), the vocabulary level of non-English major students was investigated, and the results showed that their vocabulary size was 2,703 words. Similarly, Wu (2011) revealed that the percentage of the number of students whose vocabulary size was no more less than 3,000 words accounted for 68% of university EFL counterparts. By looking more closely at the vocabulary size of non-English majors from two aspects, Wang (2010) found that their average receptive vocabulary size was about 3,000 words, and their average controlled-productive size was 1,142 words. Compared with the requirement of 4,500 words for passing CET4 in China or the requirement of an 8,000 - 9,000 word-family to be competent in different English skills as proposed by Nation (2006) and Schmitt (2010), the vocabulary level can be considered as at a low level among Chinese university students. Their low vocabulary level can be attributed to the following reasons.

One reason may have something to do with the disadvantages of wordlist-based teaching and learning, for example, easily making learners confused and forgetful (Mondria et al., 1991), useless in students' forming a semantic network (Gui, 1991), fast memory loss of vocabulary (Oxford & Scarcella, 1994), and low efficiency in memorizing words (Ye, 2016).

The other reason may be due to limited classroom time for Chinese university students to learn vocabulary. Non-English major students only attend an English course for two hours per week for four semesters, and no course is offered for vocabulary

learning (Ministry of Education, 2007). Nevertheless, vocabulary knowledge is considered as a continuum or incremental in nature, which cannot be achieved through a limited time (Henriksen, 1999; Schmitt, 1998a, 2000). Also, it has been pointed out that EFL vocabulary learning and retention are time-consuming tasks in EFL settings (Chumcharoensuk, 2013; Ko & Goranson, 2014; Somnuek, 2011; Zeng, 2012). Therefore, limited in-class time will not be sufficient to enable EFL learners to achieve wide vocabulary knowledge.

Providing students with contextualized vocabulary learning and making use of their fragmented time together may be a possible way to improve their vocabulary learning and retention. To achieve this goal, MALL could be a useful tool because of the following reasons.

Firstly, MALL can provide a variety of multimedia, such as texts, pictures, sounds, animations and videos by easy access to the internet, allowing for creating authentic, meaningful vocabulary learning environments, which not only stimulate learners' motivation and interest but also help them understand words easily, resulting in good vocabulary learning and retention (Al-Seghayer, 2016; Gonulal, 2019; Govindasamy et al., 2019; Mayer, 1997; Ramezanali, 2017; Wang, 2015).

Secondly, the time and space flexibility of using mobile devices enables students to choose convenient times for vocabulary learning anywhere since their amount of classroom time is limited. Therefore, learners who can use MALL have an opportunity to learn and retain their vocabulary knowledge whenever and wherever they want (Cheung, 2012; Kiliçkaya, 2007).

Furthermore, the immediate feedback offered by MALL can facilitate vocabulary

learning with the increase of "cognitive involvement load" (Hulstijn & Laufer, 2001), by helping learners store the correct meanings as well as forms of words in their minds (Henderson, 2019; Soria et al., 2020; Sprenger, 2018). The cognitive involvement load hypothesis (Hulstijn & Laufer, 2001) indicates that how well a word is learnt depends upon cognitive processing degree needed for a task. Hence, the more cognitive involvement the students have in MALL, the better the performance they can achieve in vocabulary learning.

Finally, it has been found that mobile devices have positive effects on L2 vocabulary acquisition, such as improving vocabulary learning with flashcards of mobile phones (Basoglu & Akdmir, 2010), learning more English idioms via Short Message Service of mobile phones (Hayat, Jalilifar, & Mashhadi, 2013), and enhancing students' engagement in vocabulary learning through smartphones (Wu, 2015).

Perceptions of MALL

The learners' perceptions of learning can be an indicator of their level of language acquisition. According to Yu (2019), the learners' perceptions of technology had a direct impact on their language learning. Additionally, Muhanna and Abu-Al-Sha'r (2009) explored how university students perceived a learning environment with cell phones by selecting twenty graduates and thirty undergraduates of Jordan as samples. They found that those who preferred learning by using cell phones were the undergraduates, while graduate students did not. Barbour et al. (2014) probed into students' perceptions of mobile learning in one virtual school, and found that they were not fond of mobile learning. However, Bensalem (2018) investigated EFL learners' perceptions of learning vocabulary through WhatsApp, and revealed that they held positive perceptions of learning words via WhatsApp. Also, Gonulal (2019) revealed that English language

learners' experiences of employing Instagram to learn a language learning were mainly good. In terms of the studies above, it can be stated that EFL learners' perceptions of MALL are various.

Furthermore, little research has been done on L2 vocabulary learning through mobile applications (Afzali et al., 2017; Burston, 2013). Therefore, in order to fill in the gaps and follow the changes of times, the first aim of the present study was to develop a mobile application, especially for vocabulary learning and retention among Chinese university students. The next aim was to test its effects on their vocabulary learning and retention. Additionally, their perceptions of the mobile application were explored, because little research has focused on using technology in English learning among university students in China (Yu, 2019) and various perceptions of MALL emerged (Barbour et al., 2014; Bensalem, 2018; Gonulal, 2019; Muhanna & Abu-Al-Sha'r, 2009).

1.3 Purposes of the Study

One purpose for the present study was for using a theory-based mobile app as a means for Chinese university students to learn vocabulary, which can be employed outside the classroom with the hope of improving their EFL vocabulary learning and retention. The other is to examine whether the mobile app can positively affect EFL learners' vocabulary learning and retention in a Chinese EFL setting. The purposes of this study are listed as follows:

1) To investigate what effects a theory-based mobile app has on EFL students'

vocabulary learning achievement1.

2) To examine what effects a theory-based mobile app has on EFL students' vocabulary retention2.

3) To explore EFL students' perceptions of using a theory-based mobile app to learn EFL vocabulary.

1.4 Research Questions

According to purposes of this study, three research questions were proposed:

1) What are the effects of using a theory-based mobile app on EFL students' vocabulary learning achievement?

2) What are the effects of employing a theory-based mobile app on EFL students' vocabulary retention?

3) What are the EFL learners' perceptions of vocabulary learning via a theory-based mobile app?

1.5 Significance of the Study

Firstly, this study fills in the research gap with a mobile app specially designed for vocabulary learning and adds to research on mobile app-assisted EFL vocabulary learning in the Chinese EFL setting as little empirical research has been carried out so far based on the researcher's literature review.

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[1] The operational definition of vocabulary learning achievement means the scores that the students achieve in the Knowledge Scale of Target Words for the post-test.

[2] The operational definition of vocabulary retention means the scores that the students achieve in the Knowledge Scale of Target Words for the delayed post-test.

Secondly, the mobile app is based on the design principles of MALL, vocabulary learning, and memory theories, especially for vocabulary learning (see details in section 2.1), so the findings of the study will help mobile app developers to assist in vocabulary learning in EFL settings.

Thirdly, the results from learners' perceptions of mobile-assisted vocabulary learning in this study offer guidelines to the writers of vocabulary learning materials as well as mobile app developers.

Fourthly, the present study, with its focus on CET4 (College English Test Band-4) vocabulary learning and retention via a mobile app, is especially helpful in the Chinese EFL setting where all non-English majors have hopes of passing the national CET4 before graduation.

Finally, this study may enrich the understanding of using a mobile app in the Chinese EFL context for both pedagogical and methodological reasons. For vocabulary pedagogy, English teachers can require students to learn words via mobile apps with carefull monitoring. As for the methodological reason, students can not only study words in classrooms or from textbooks, but also use mobile apps to learn vocabulary for offsetting the weaknesses of traditional vocabulary learning.

1.6 Scope of the Study

1) The context of this study was the EFL setting of China. The present study was carried out at a local university in the southwest of China, where the English proficiency of the university students is low and cannot be compared with their counterparts from Central or Eastern China. For this study, 114 freshmen out of 850 non-English major newcomers in the 2019 academic year were chosen as participants.

2) The focus of this study was to examine the effects of using a mobile app on EFL learners' vocabulary learning and retention. The mobile app used in this study was developed by a computer engineer for which the vocabulary learning activities were designed by the researcher.

1.7 Limitations of the Study

A number of participants in this study were selected from a limited population of undergraduates at a local university in China. Therefore, the participants may not be representative of students who enroll in other universities, because they may have different vocabulary proficiency, learning environments, and needs.

Furthermore, the participants in the study were selected based on availability and convenience. This kind of sampling procedure probably restrains the generalizability concering the results of the study.

Lastly, the subjects were from first-year non-English majors. So the university counterparts among various majors and at different levels were excluded, then the scope of the findings' generalizability is limited.

Because of these limitations, it should be cautious to treat those findings from this study in making generalizations concerning university students' vocabulary learning via a mobile app in the Chinese EFL setting.

1.8 Definitions of Key Terms

1) **Mobile-Assisted Language Learning (MALL) or M-learning or Mobilearn** (Chinnery, 2006) refers to any kind of learning language via mobile facilities, such as

smart phones, MP4/MP3 players, tablets, or electronic dictionaries (Kukulska-Hulme & Shield, 2008).

2) **A mobile device** is referred to as any device being automatic, small-sized, to keep us company all the time (Trifanova et al., 2004). In the present study, mobile devices refer to smart mobile phones (smartphones).

3) **A mobile app** is a computer program developed for operating on a portable devicen such as smartphones or tablets. The term "app" is a short name of "software application." Technology columnist David (2009) argued that nowadays smartphones can be called "app phones" to differ from less-sophisticated ones.

4) **EFL** stands for English as a foreign language (EFL) in the study, which refers to the English language learned by non-native speakers as a foreign language at the environment in which English is not used as his/her mobther language.

5) **EFL learners** refers to the people learning English as a foreign language in the EFL context who are called EFL learners. In this study, EFL learners refers to any one who learns or uses English non-natively in China.

6) **Non-English majors** refer to students whose majors are not the English language at university, and who learn English mainly for graduation and good jobs.

7) **Vocabulary** is defined as a collection of words in a language that consists of word forms (spelling and sounds) and word meanings used in various contexts in order to convey different meanings (Gutlohn, 2006; Hubbard, 1983; Jackson & Amvela, 2000). In this study, vocabulary refers to the vocabulary in College English Test Band-4 (CET4) of China, which university students have to master in order to pass it.

8) **Vocabulary learning** is the process of acquiring vocabulary knowledge, which

commonly includes vocabulary size and depth (Qian, 1999, 2002; Wesche & Paribakht, 1996). Vocabulary size means a learner's vocabulary size (Nation, 2001) or the amount of words about which one knows something related to their meanings (Stahr, 2009). Vocabulary depth means how well he/she knows vocabulary, or one learner's knowledge level concerning every aspect of vocabulary (Qian, 1999; Read, 1993).

9) **Vocabulary retention** refers to the ability to remember or retain vocabulary in mind (Maryam & Ahmad, 2017) or the ability to provide the meaning of a new word after a given period of time (Ramezanali, 2017). In the study, vocabulary retention means how many the students can retain four weeks after studying target words.

10) **Vocabulary Size Test (VST)** is an instrument to assess the total vocabulary size for ESL/EFL learners and was constructed by Nation and Beglar (2007).

11) **Vocabulary Knowledge Scale (VKS)** is a measurement that gauges a broad range of word knowledge types: being aware of a word's form, knowing a word's form-meaning link, using a word to make sentences, and was developed by Paribakht and Wesche (1993).

12) **CET4** is the abbreviation of College English Test Band 4, which is a nation-wide standardized English level test for Chinese non-English majors, which has been held twice a year since 1987.

13) **TEM4** refers to Test for English Majors Band 4, which is a nation-wide standardized English test for English majors of China, which has been held once a year since 1991.

14) **Perception** is referred to as "the ability to see, hear, or become aware of something through the senses" in the first paragraph of the Oxford dictionary of American English (2014). In the study, the components of perception consist of

attitudes towards using, continued intention to use, perceived convenience, perceived ease of use, as well as perceived usefulness.

1.9 Summary

this chapter firstly states the current background of the study, followed by problems' statement, the research purposes and questions, the significance, the scope, the limitations, and the key terms' definitions are also introduced. in the upcoming chapter, a review of the literature concerning theories and related research about vocabulary learning as well as studies about mall are presented.

CHAPTER 2

LITERATURE REVIEW

This chapter begins with an introduction to the theoretical framework for the present study. Next, several constructs central to the present study, including vocabulary, vocabulary knowledge, vocabulary retention, are presented, and related research is reviewed. Later, mobile-assisted language learning (MALL) is introduced, and the studies on MALL are presented. Then, a review of the research on EFL vocabulary learning and retention through MALL is given. Moreover, the gaps in the previous studies on mobile-assisted EFL vocabulary learning and retention are pointed out, and the present study is proposed. Finally, this chapter ends with a summary.

2.1 Theoretical Framework

The design of the mobile app and the presentation of the vocabulary contents in the present study are based on four theories, which are derived from ten design principles for MALL (Stockwell & Hubbard, 2013), dual coding theory (Paivio, 2007,1986,1971), the cognitive theory of multimedia learning (Mayer, 2005, 1997), and the memory-based strategic framework for vocabulary learning (Ma, 2014a). Then, they are introduced respectively, and the implications for the present study are also presented.

2.1.1 Ten Design Principles for MALL

Stockwell and Hubbard (2013) proposed ten principles for the design and implementation of mobile devices as well as tasks using mobile functionalities in language learning environments based on theories from MALL, ML (Mobile Learning), and CALL (Computer-Assisted Language Learning). They examined the studies from MALL, exploring the issues that emerged from this body of research through a framework distinguishing physical, pedagogical, and psycho-social dimensions. Recognizing not only the contributions, but also the limitations of existing MALL literature, they then identified the findings from the closely allied fields of ML and CALL that could inform both research and practice in MALL. Drawing from MALL, ML, and CALL, they put forward ten general principles to guide teachers and learners on how to integrate mobile devices and tasks into language learning environments effectively.

Principle 1: Mobile apps, tasks, and activities should distinguish both 1) the affordances and limitations of the mobile device, and 2) the affordances and constraints of the environment in which the device will be used in the light of the learning target (Herrington et al., 2009; Reinders & Hubbard, 2013).

Principle 2: Limit multi-tasking and environmental distractions. According to Ophir et al. (2009), most people are not good at multi-tasking, and it may increase stress levels, error rates, and lower productivity. Furthermore, it is likely to interfere with both deliberate and incidental language learning.

Principle 3: Push, but respect boundaries. Stockwell (2013) found that the push mechanism has the potential to remind learners to take action, but at the same time, learners should know when and how frequently they may receive these reminders

(Kennedy & Levy, 2008). These reminder messages have the potential to shift learners' attention to the learning task.

Principle 4: Strive to maintain equity. In a formal or an informal language learning setting, essential issues should be considered that include whether the learner owns a mobile device, what device the learner has in terms of functionality and compatibility, how consistent its connectivity is, and what the expense is for employing the devices to carry out tasks in language learning.

Principle 5: Acknowledge and plan for accommodating language learners' differences. According to Chun (2001) and Heift (2002), learning styles and learners' differences in a public or a private place should be taken into account in mobile learning.

Principle 6: Be aware of language learners' existing uses and cultures of use with their devices. Liu (2013) and Stockwell (2010) found that students may consider their mobile devices as being for personal and social use rather than as educational tools. So the more consistent a task or app is with its purpose, the more likely learners will accept it.

Principle 7: Keep mobile language learning activities and tasks short and succinct when possible. According to mobile learning frameworks put forward by Elias (2011) and Herrington et al. (2009), long activities or tasks should be divided into short, coherent ones.

Principle 8: Let the language learning task fit the technology and environment, and let the technology and environment meet the task. If there is an assumption that learners will use a mobile phone at short intervals during the day (e.g., 10 minutes between classes) in settings where it may be challenging to incorporate sound, then tasks should be designed for fitting that environment. If there is another

assumption that learners would do a task that requires reading substantial texts or videos from the screen, then appropriate technology (e.g. smartphones with bigger screens) and a quiet environment would be needed.

Principle 9: Some, possibly most, learners will need guidance and training on how to use mobile devices for language learning effectively. Hubbard (2013) claims that it is necessary to make learners aware of the impacts of task learning and the environment in which they use mobile devices, and then to train them to use mobile devices for doing a task as efficiently as possible.

Principle 10: Recognize and accommodate multiple stakeholders. For example, in the workplace, the impact of the potential ubiquity of mobile learning on co-workers, bosses, and productivity should be taken into account.

Applications in the present study: Table 2.1 below illustrates how each principle is used

Table 2.1 The ten design principles and their applications in the present study

Principles	Adaptions in the present study
1. Mobile activities, tasks, and apps should distinguish both 1) the affordances and limitations of the mobile device and 2) the affordances and limitations of the environment in which the device will be used in the light of the learning target.	Students can download and install the mobile app for the first time through smartphones to learn and review vocabulary on their own.
2. Limit multi-tasking and environmental distractions	The tasks of one-word learning consist of a Learning Section and a Retrieval Section (see 3.3.2).

Table 2.1 The ten design principles and their applications in the present study (Continue)

Principles	Adaptions in the present study
3. Push, but respect boundaries	Students would receive a message on smart phones that their diaries are due, which helps them carry out the learning schedule.
4. Strive to maintain equity	Every student in the experiment group owns a smart-phone with similar capacities, such as approximately a 5-inch screen, an android operating system, and a wireless network function.
5. Acknowledge and plan for accommodating language learners' differences	Students have very similar learning and living environments, as they are classmates and live in the dormitories of university in the 2019 academic year.
6. Be aware of language learners' existing uses and cultures of use with their devices	The subjects are all Chinese, and they mainly use QQ and WeChat for communication, so the cultures for using their smart-phones are similar.
7. Keep mobile language learning activities and tasks short and succinct when possible	Students are required to learn ten words via the app at a time which will not surpass their working memory capacity (Miller, 1956). Besides, the vocabulary in the app is presented in multimedia and is simple to follow.
8. Let the language learning task fit the technology and environment, and let the technology and environment meet the task	The tasks are for students to read short texts with big fonts from the screen and they can watch the images or listen to audios of the words with a loudspeaker/ earphones.
9. Some, possibly most, learners will need guidance and training on how to use mobile devices for language learning effectively	Instructions on how to use the app to learn and review vocabulary should be provided in detail to the students in the first class.
10. Recognize and accommodate multiple stakeholders	The students with the mobile apps are required to learn or review words on their own, so the impacts on mobile apps' usage from their classmates, teachers, or other people can be ignored.

2.1.2 Dual Coding Theory

Definition DCT (Dual Coding Theory) proposed by Paivio (2007, 1986, 1971) attempts to give equal weight to verbal and non-verbal/visual systems, and to explain the powerful effects of mental imagery on the memory.

Verbal and Non-verbal Systems The verbal system stores and processes linguistic information/units (such as text and sound), and the non-verbal/visual system stores and processes visual information/units (such as pictures, animations, and videos). Also, these verbal and non-verbal/visual systems interact, and the activation of both systems results in better recall (Al-Seghayer, 2001; Paivio, 2007).

According to Paivio (1986), and Clark and Paivio (1991), three different processing levels (i.e., representational, referential, and associative processing) take place within or between verbal and nonverbal/ visual systems. Representational processing refers to the activation of the verbal and visual representation by a stimulus as words or sounds can activate verbal representation and pictures visual representation. Referential processing refers to the activation of one system by the other; that is, words in the verbal system can activate images in the non-verbal/visual system and vice versa. Associative processing refers to the activation of additional information in representational or referential systems. At this level, the associative connections between words or sounds in the verbal system and images in the visual system are activated.

Accordingly, words associated with images are acquired more quickly and retained more effectively than those which are presented alone (Clark & Paivio, 1991).

Ramezanali (2017, p.141) states that “use of pictures and illustrations associated with unknown words are effective instructional devices that are superior to words alone for memory tasks and will help L2 learners remember the words sooner and retain them longer”. Lin (2009) claims that the dual association of verbal and visual modes are also valid for recall, because “when one memory trace is lost, the other remains and is accessible” (p.24). Exposing learners to multiple ways of presentation, such as printed text, sound, pictures, and video/animations, can produce a language learning environment with a significant effect on vocabulary learning (Al-Seghayer, 2016, 2001).

Application for the current research The target words in the mobile app are presented in both visual and audio ways for activating the learners’ two systems to facilitate their learning and retention.

2.1.3 The Cognitive Theory of Multimedia Learning

Definition The cognitive theory of multimedia learning (CTML) is about how people learn from multimedia presentations (Mayer, 2005, 1997). It is based on three assumptions, which are dual channels, limited capacity, and active processing.

Three assumptions: The assumption of dual channels suggests that humans have two separate information processing channels (auditory/verbal and visual/pictorial). The auditory/verbal channel receives information (such as spoken words, narration, or sounds) through the ears and the visual/pictorial channel receives information (such as pictures, videos, or on-screen texts) through the eyes.

The second assumption of limited capacity signifies that there is a limit on the amount of information that learners can process in one of the above two channels at one time. This may be the reason why learners can only hold a few words in the

auditory/verbal channel of their working memory at one time when presented with narration, and the same is also true of the visual/pictorial channel (Mayer, 2005).

Lastly, for building a connection between verbal and visual representations and integrating them into the learners' existing knowledge, some cognitive activities should be processed in long-term memory and brought back into the working memory. This cognitive process accounts for the third assumption of active processing. In detail, the assumption of active processing includes:

> "(1) Selecting relevant words for processing in the verbal working memory, (2) selecting relevant images for processing in the visual working memory, (3) organizing selected words into a verbal model, (4) organizing selected images into a pictorial model, and (5) integrating the verbal and pictorial representations with relevant prior knowledge activated from the long-term memory." (Mayer, 2005, p.54).

Figure 2.1 below shows the processes of learning L2 vocabulary in a multimedia-based setting

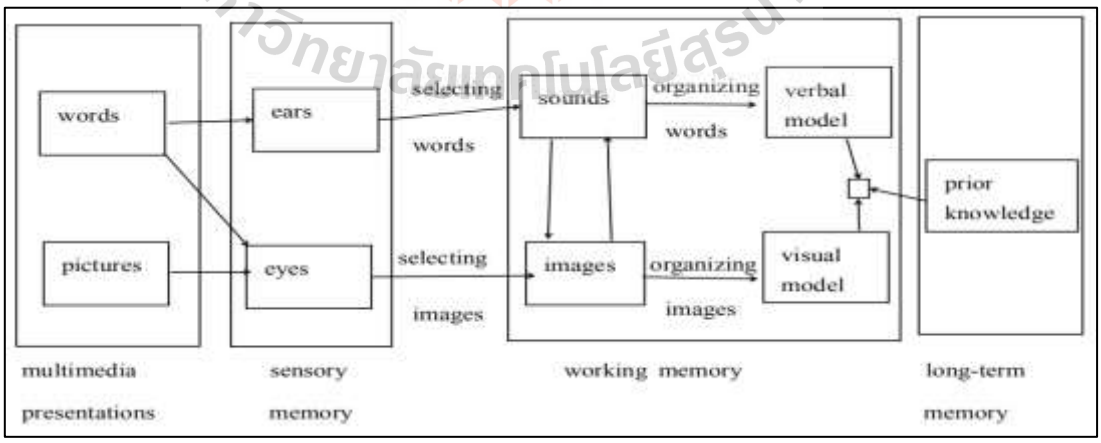


Figure 2.1 Cognitive theory of multimedia learning (Mayer, 2005, p.52)

Figure 2.1 shows that words and pictures, as the two multimedia presentation modes, come to the sensory memory through the ears and eyes from outside. Words are kept in the auditory sensory memory and pictures in the visual sensory memory temporarily. Later, learners can select materials by giving their attention to the appropriate words and pictures. When the relevant materials are selected, structural relations are built between the elements in the working memory. Then, the information is transferred to the working memory, where materials are temporarily held and manipulated.

As illustrated in Figure 2.1, working memory consists of two dimensions: the left side represents "the raw material" such as "verbal words and visual images", and the right side "the knowledge constructed in the working memory" such as "verbal models and visual models and the links between them" (Mayer, 2005, p.53). On the right hand side of Figure 2.1, the last box shows long-term memory, which can hold large amounts of information over long periods. However, according to Mayer (2005), for the materials to stay in the long-term memory, they should be actively moving back and forth from long-term memory to working memory, as shown in Figure 2.1 above. In this way, knowledge in the long-term memory can be activated and brought into the working memory if there exists a connection between new materials and the learners' prior knowledge (Mayer, 2005).

Two principles of multimedia learning: One principle is the multimedia principle (Fletcher & Tobias, 2005; Mayer, 2005), and the other is the temporal contiguity principle (Mayer & Fiorella, 2014). According to Fletcher and Tobias (2005), and Mayer (2005), the multimedia principle suggests that learners can learn more

effectively if they are presented with words and pictures rather than words alone. Also, Butcher (2014) claims that the multimedia principle is not limited to words and pictures but refers to a broader term encompassing different forms of visual and verbal representations when presented together. According to Sweller (2005), it was assumed that L2 learners could learn the target words better and more effectively when offered in dual modes rather than a single mode, for using both words and pictures allows the brain to process more information in the working memory, and can be recalled from the long-term memory when required.

The temporal contiguity principle refers to learners learning more deeply from learning media when the text, audio, pictures, and video/animation are presented simultaneously rather than successively or sequentially (Mayer & Fiorella, 2014). Moreover, learners must have corresponding words and images in the working memory at the same time to make connections between them, which means that simultaneous presentation is likely to result in better learning than successive and separate presentations (Mayer, 2008; Rusanganwa, 2015).

Application In the present study, text, audio words, as well as Chinese definitions and pictures are used as the verbal and visual components to present the target words for the learners. In addition, both the verbal and visual elements concerning the target words are displayed simultaneously in the mobile app.

2.1.4 Memory-based Strategic Framework for Vocabulary Learning

Definition The memory-based strategic framework for vocabulary learning is proposed by Ma (2014a) based on the findings of memory in psychology and L2 vocabulary acquisition. The framework is illustrated in Figure 2.2 below.

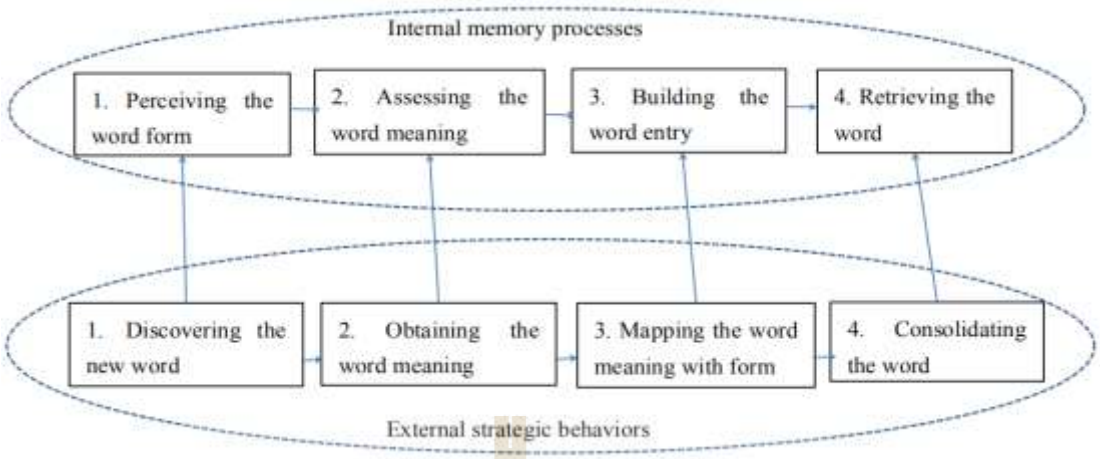


Figure 2.2 Memory-based strategic framework for vocabulary learning (Ma, 2014a, p.43)

Four-stage vocabulary learning process For each stage, a cognitive process takes place invisibly in the internal memory system, and a corresponding external, strategic behavior takes place as well. Firstly, the new word in a visual or auditory form needs to be noticed by the brain. Secondly, the meaning of the new word needs to be accessed, which could be achieved by looking it up a dictionary or other sources. Thirdly, the original word needs to be established as a new L2 lexical entry in the brain by connecting the meaning (L1 definition) with the new form via repetition or imagery. Finally, each time the newly learned word is retrieved for receptive or productive use, the memory trace for the word will be strengthened.

Application in the present study In the first stage, the target word in the mobile app is presented in both visual and audio modes simultaneously to attract students' notice. In the second stage, students can find the meaning of the target word by looking at the Chinese definition and the example sentence. In the third stage, to help students map the meaning of the new word with its form, two multiple-choice exercises,

the first ‘selecting the right meaning for a given word’ and the second ‘selecting the right word for a given meaning,’ are provided for students to complete. In the fourth stage, to consolidate the words in students’ minds, spelling exercises for students to write down the corresponding English words based on Chinese meanings are provided to help them retrieve the words they have learned from memory.

Feedback is provided in form of pop-ups when students finish any kind of exercise in the present study. It includes both positive and negative feedback which increases learning as the practice-takers can correct errors and make correct responses (Pashler, 2005; Roediger & Butler, 2011). In Figure 2.3 below, when students do the first multiple-choice exercise for the word ‘involve’, on touching the third column (right answer), they would see positive feedback with a tick (‘√’). However, on touching one of the other columns, they would receive negative feedback with a cross (‘×’) and then they are automatically linked to the learning section of ‘involve’.

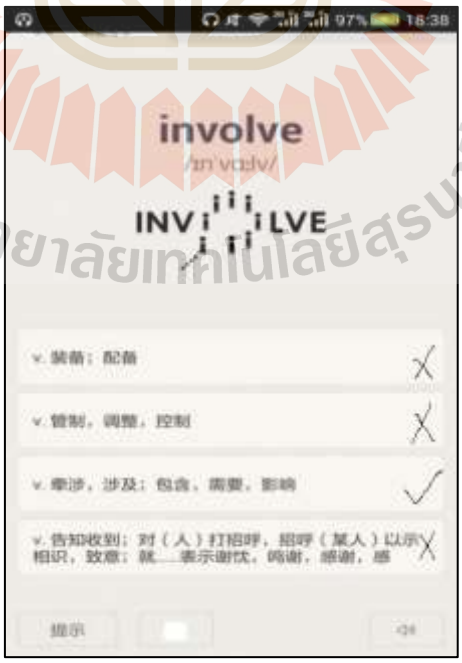


Figure 2.3 The picture of the word ‘involve’ in the first multiple-choice with feedback

2.2 Vocabulary Knowledge

Firstly, a definition of vocabulary is presented in this section. Then, two components comprising vocabulary knowledge are provided. Next, studies over the correlation between vocabulary knowledge and different language skills, as well as language proficiency, are reviewed.

Hubbard (1983) defines vocabulary as a dominant carrier of meaning. More specifically, Jackson and Amvela (2000) regard that vocabulary is a collection with words or a package of sub-sets of words employed for particular contexts or in a certain textbook. From another perspective, Diamond and Gutlohn (2006) argues that vocabulary is a knowledge of words' forms and their meanings, and can be applied receptively or productively for various meaning making.

Based on the above definitions, vocabulary can be seen as a collection of words in a language that consists of word forms (spelling and sounds) and word meanings used in various contexts to convey different meanings. Therefore, when learners learn vocabulary, they not only learn the vocabulary forms and meanings, but they also learn the appropriate usage of the vocabulary.

2.2.1 Two Dimensions of Vocabulary Knowledge

Although researchers regard vocabulary knowledge as comprising multidimensional aspects (Chapelle,1998; Henriksen,1999; Nation,2006; Qian,2002; Richards,1976), vocabulary knowledge should include two primary dimensions: size/ breadth and quality/depth, which are accepted commonly (Qian,1999, 2002; Read,1993; Wesche & Paribakht, 1996).

Vocabulary size Breadth of vocabulary knowledge is defined as the size of

a learner's vocabulary (Nation, 2001) or the number of words of which the learner has at least some knowledge of the meaning (Qian, 2002; Stæhr, 2009). Meara (1996) believed that vocabulary size is a basic dimension to judge a learner's vocabulary knowledge, and claimed that students with larger vocabularies are more likely to be proficient in English than those with little vocabulary size. As for L2 learners, researchers have revealed their insights about the number of word families L2 learners typically need to acquire to function in diverse contexts (Ko, 2012; Laufer, 2003; Nation, 2006). A word family includes a base word, its grammatical inflections, and its closely related derivatives (Nation, 2001).

For L2 learners, Nation (2006) estimated that a 6,000 to 7,000-word family got from Wellington Corpus of Spoken English is needed to function in a speaking context, and 8,000 to 9,000-word families (based on the British National Corpus)) is needed to function in a written context. These estimates are based on the criterion that they would account for 98 percent of vocabulary coverage (Adolphs & Schmitt, 2003), that is, the percentage of known words in all contexts.

It was demonstrated that it is necessary for L2 learners' mastering a 5,000 to 10,000-word family to infer new words right during university-level passage reading (Coady, 1997; Huckin & Coady, 1999; Ko, 2012; Nation, 2006). Therefore, it is not difficult to understand that this enormous figure demonstrates a significant challenge facing L2 learners. In other words, that they have to learn thousands of words in the target language.

Measurements for Vocabulary Size At present, two widely accepted and validated measurements for gauging learners' vocabulary size are the Vocabulary

Levels Test (VLT) (Nation, 1990; Schmitt et al., 2001) and the Vocabulary Size Test (VST) (Nation & Beglar, 2007).

Vocabulary Levels Test (VLT) It contains 5 tests with 4 different word - frequency levels tests and an Academic Word List developed by Nation (1990). According to Nation (2001, p.373), the VLT measures "whether the learner knows enough of the vocabulary at a given word level for instruction to move on to the next frequency level". Among the first four levels, the 2,000 and 3,000-word levels are representatives of high-frequency words. The 10,000-word level covers low-frequency words. The 5,000-word level is the dividing line between the high-frequency and the low-frequency level. The Academic Word List is the one that university students often encounter in their textbooks.

Format of VLT Six clusters comprise each level, and each cluster is composed of 6 words on the left as well as 3 short definitions on the right. Among the six words, the test-takers are required to choose three counterparts, which correspond to the three definitions. One example below is taken from VLT (Nation, 1990) to illustrate the above descriptions.

Instructions: you can select the right word from the left side matching with meanings of the right side. Fill in the number in the appropriate square frame. An example is taken as follows.

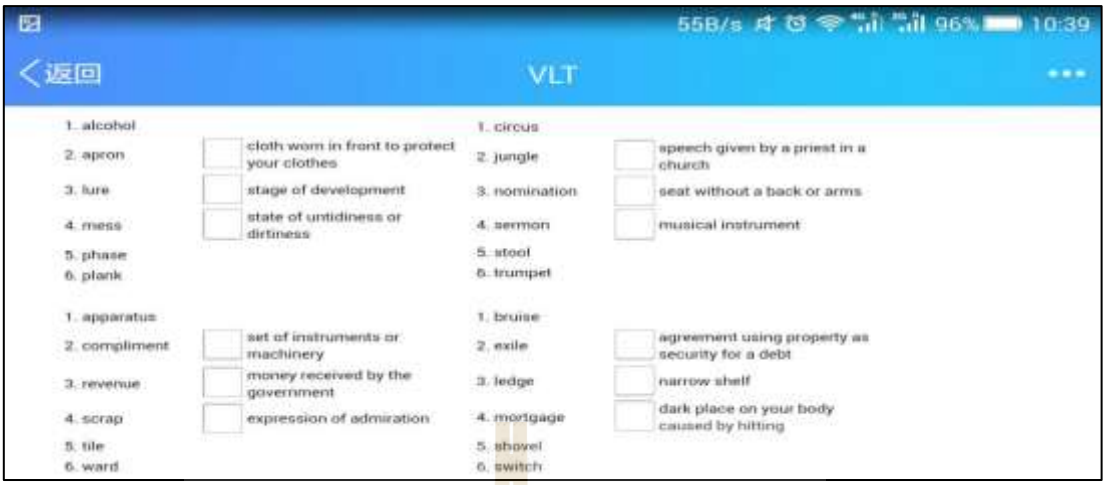


Figure 2.4 A picture of 5,000-level items in VLT (Nation, 1990)

VLT has been proved to be a useful diagnostic tool for the vocabulary levels of migrant or international students in an English-speaking country. Moreover, VLT is a very reliable instrument in measuring the vocabulary size of a language learner (Zhang, 2012) and has been used as a measurement of vocabulary size in many studies (e.g. Afshari & Tavakoli, 2017; Guo, 2017; Liu, 2016; Staehr, 2009; Wang, 2010; Zhang, 2011; Zhang, 2012; Zha, 2015).

Vocabulary Size Test (VST) Nation and Beglar (2007) designed the VST as a tool for measuring vocabulary size of ESL/EFL learners. It consists of one hundred and forty items with ten items forming each of fourteen 1,000-word levels selected from British National Corpus.

Format of VST The test has a four-item multiple-choice format. A sample item below is taken from the fifth 1,000-word level of VST (Nation & Beglar, 2007).

Instructions: in each item, you should choose the right meaning from a, b, c, d to go with the word in CAPITAL letters by clicking the small circle. Here is an

example, as displayed in Figure 2.5 below.

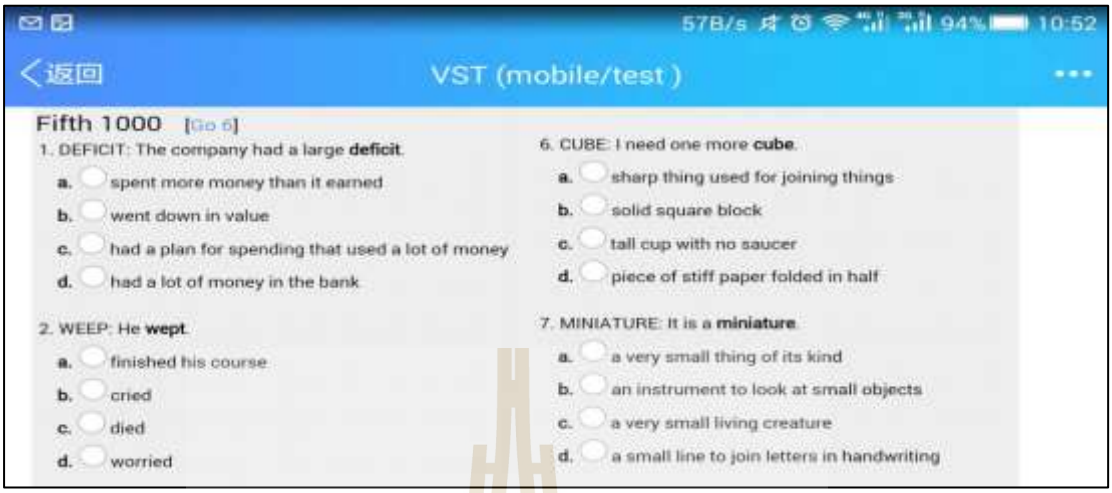


Figure 2.5 The picture of 5,000-word level in VST (Nation & Beglar, 2007)

Each tested word is situated in one simple sentence context. Because every word item in the test stands for a 100-word family and ten ones form a 1,000-word frequency level, a learner's total vocabulary size can be attained with her/his scores of the test multiplying by 100.

To sum up, it can be seen that the above breadth or size tests can provide the necessary measurements for vocabulary size of learners, but the way of assessing how well a student masters a word is not given. To find out the extent of a learner knowing a word, a method is illustrated below.

Vocabulary Depth This means a student's knowledge level of different aspects about a word, or the extent of her/his mastering one word (Qian, 1999; Read, 1993). For measuring vocabulary depth, two reliable and popular tests are the Word Associates Test (Read, 1998, 1993) and the Vocabulary Knowledge Scale (Paribakht & Wesche, 1997).

Word Associates Test (WAT) This is a measurement for assessing

vocabulary depth through word associations, and was developed by Read (1993) and revised by Read (1998) later. Word associations mean different collocational and semantic correlations that one word exhibits with other words. It can be used as an examination for testing the extent of your knowing the meanings of the adjectives employed frequently in English. The test contains forty items. One item comprises an adjective followed by 8 words, 4 of which are relevant to target word's collocation and meaning, but the other 4 are not. Test-takers are required to pick out 4 words closely correlated to target word, so the number of right choices is 4.

Format of WAT Instructions: please choose four words in total from the two boxes which are the meanings and collocations of the word in bold.

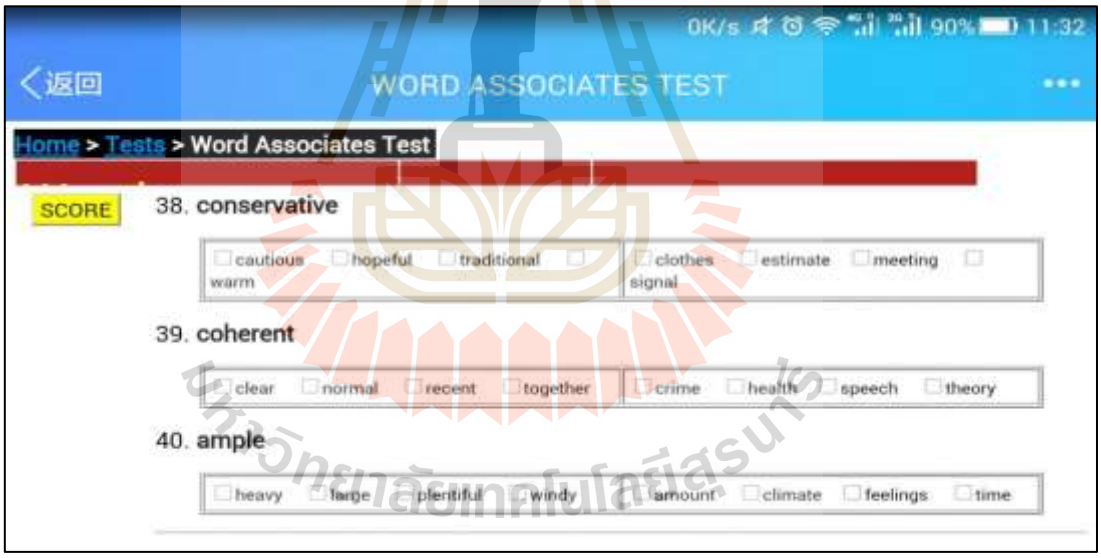


Figure 2.6 The picture of the last three items in WAT (Read, 1998)

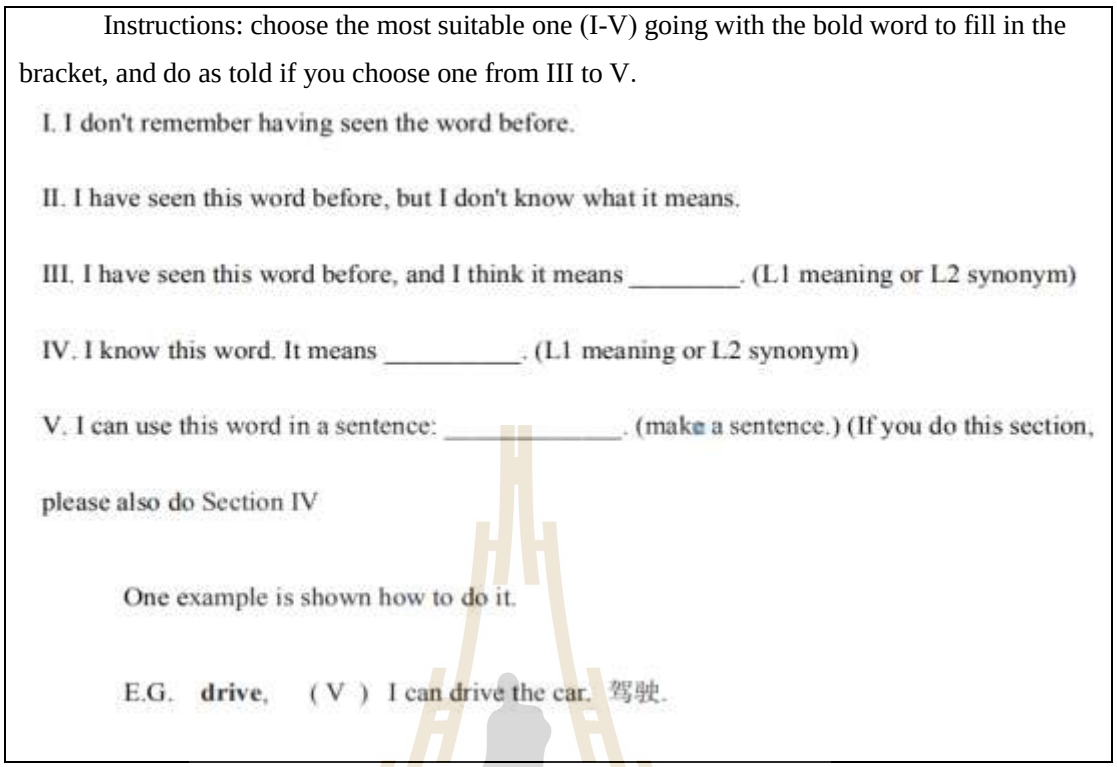
In the left hand box above, there are synonyms (one to three) of the target word (ample), and in the right hand box, one to three words are collocations of the target word (ample). So in this sample, the correct choices from the left hand box are 1 and 3, and the correct ones from the right hand box are 5 and 8 with two correct choices in the

left hand box and two correct ones in the right hand box. However, exceptions exist. For example, there may be one, two, or three correct choices in the left hand box and three, two, or one correct choices in the right hand box, respectively, because there are four correct choices in total. In scoring, the test-takers received one score with one correct word. The maximum scores are 160 for 40 items. It probably takes test-takers 35 minutes to finish all items.

WAT is regared reliable with a high coefficient up to 0.93 (Read, 1998), and researchers like Qian (1999, 2002) and Nassaji (2004) have also stated that the coefficient of WAT reliability is more than 0.9. Therefore, it has been adopted in vocabulary studies to measure vocabulary depth (Afshari & Tavakoli, 2017; Greidanus & Nienhuis, 2001; Guo, 2017; Liu, 2016; Staehr, 2009; Shi, 2012; Wang, 2010).

Vocabulary Knowledge Scale (VKS) This is an instrument for gauging how well a learner knows a given word through using a five-point elicitation scale which ranges from 'no recognition' to 'the usage of the word in a sentence context'. VKS was developed by Paribakht and Wesche (1993) and refined by Paribakht and Wesche (1997) later.

Format of VKS An example of the instructions for the Vocabulary Knowledge Scale is shown.



Instructions: choose the most suitable one (I-V) going with the bold word to fill in the bracket, and do as told if you choose one from III to V.

I. I don't remember having seen the word before.

II. I have seen this word before, but I don't know what it means.

III. I have seen this word before, and I think it means _____. (L1 meaning or L2 synonym)

IV. I know this word. It means _____. (L1 meaning or L2 synonym)

V. I can use this word in a sentence: _____. (make a sentence.) (If you do this section, please also do Section IV

One example is shown how to do it.

E.G. **drive**, (V) I can drive the car. 驾驶.

Figure 2.7 The picture of one item in VKS (Paribakht & Wesche, 1997)

These categories are coded by the VKS Scoring Scale as in Figure 2.8 below, in which possible points range from 1 to 5. As illustrated in Figure 2.8, the selection of category I would result in 1 point and the selection of category II 2 points. For categories III-V, various points can be awarded based on the quality of the answers provided.

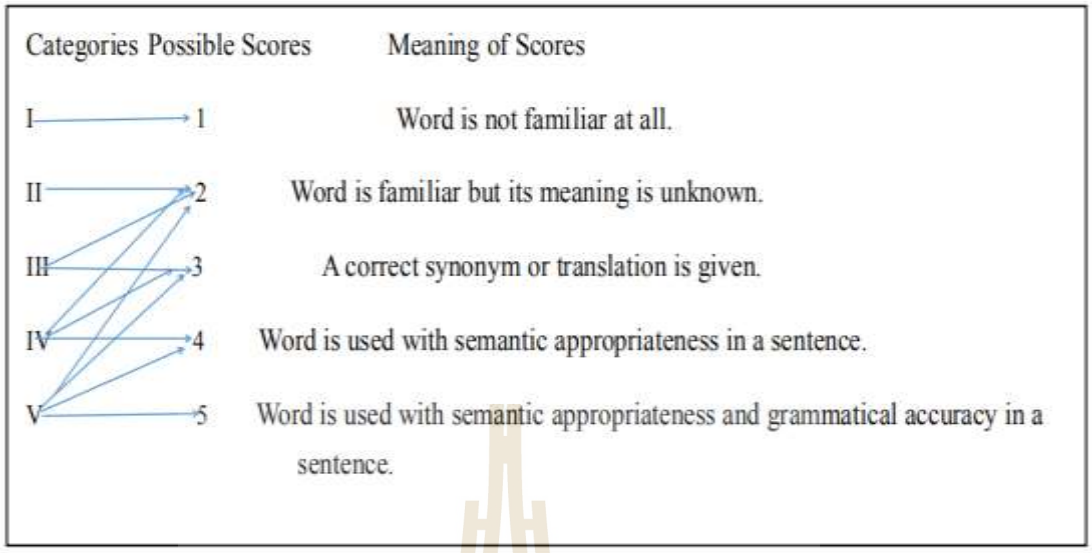


Figure 2.8 VKS Scoring Scale (Paribakht & Wesche, 1997, p.181).

The VKS reliability was as high as 0.89 (Wesche & Paribakht, 1997). The values for the reliability coefficients range from 0 to 1.0, and the value "0" means there is no reliability, and "1.0" means perfect reliability. The closer the values of the reliability coefficients are to 1.0, the more reliable the test is. So the VKS is very reliable. Next, the VKS has been proven useful in gauging the stages of vocabulary learning and retention (Paribakht, 2005; Wesche & Paribakht, 2009). Furthermore, it estimates the learning stages in the growth of vocabulary knowledge, which mean realizing a word's form, explicitly knowing a word's meaning-form link, and using a word appropriately in a sentence context.

Reasons for selecting VST and VKS In the present study, VST (Nation & Beglar, 2007) was chosen to measure the students' vocabulary size. VST was designed for measuring the total vocabulary size of ESL/EFL learners. While Nation (2001) claims that VLT (Nation, 1990) weighs if one learner knows enough words at a given word-frequency level for determing the teaching of next frequency level or not. Before

the treatment in the study, the researcher aimed to examine whether any difference on vocabulary size existed between the two groups of EFL students and whether they were qualified for the treatment or not. So it was determined that VST was more suitable for the present study.

VKS (Paribakkht & Wesche, 1993, 1997) was selected in the present study. VKS measures the vocabulary learning stages from being aware of a word form to using the word in a sentence context. These stages are very similar to the steps of learning the target words in the mobile app of the present study. Nevertheless, WAT (Read, 1993) was developed for evaluating 2 aspects of one word: collocation and meaning, which could not fulfill the aim of learning target words via the app of this study. Therefore, it was decided to use VKS for the study for it can better gauge learners' learning and retention of target words.

2.2.2 Research on the Relationship between Vocabulary Knowledge and Language Skills as well as Language Proficiency

Relationship between vocabulary knowledge and listening

A moderately to strongly positive relationship between them was revealed by the studies, with the srong correlation coefficients being 0.65 to 0.7 (Staehr, 2009), from the moderate to the strong coefficients being 0.46 to 0.52 (Zhang, 2011), from the moderate to the strong coefficients being 0.353 to 0.51 (Zhang, 2012), and with the srong correlation coefficients being 0.833 to 0.852 (Afshari & Tavakoli, 2017). They indicate that the more vocabulary knowledge students have, the better the scores they obtain in the listening sections of different tests. Table 2.2 below shows the studies concerning the participants, instruments, and correlation coefficients.

Table 2.2 The research on the relationship between vocabulary and listening

Studies	Participants	Instruments		Correlation coefficient	
		Listening tests from	Vocabulary tests	Vocabulary size	Vocabulary depth
Staehr, 2009	115 Danish freshmen	Cambridge test	VLT, WAT	0.7	0.65
Zhang, 2011	237 Chinese sophomores	TEM4	VLT, PLT	0.52	0.46
Zhang, 2012	126 Chinese college students	CET4	VLT, WAT	0.51	0.353
Afshari and Tavakoli, 2017	32 Iranian students	TOEFL	VLT, WAT	0.852	0.833

Notes: PLT for Productive Levels Test (Laufer & Nation, 1999); the correlation coefficient ranges from -1 to 1, the greater the coefficient, the closer the correlation.

Relationship between vocabulary knowledge and speaking

Vocabulary knowledge has a positively moderate or strong correlation with speaking based on these studies: Guo (2017); Milton et al. (2010); Shi (2012); and Zhang (2015). This signifies that learners' speaking performances improve with increasing vocabulary knowledge. Table 2.3 below illustrates the studies by the participants, instruments, and correlation coefficients.

Table 2.3 The research on the relationship between vocabulary and speaking

Studies	Participants	Instruments		Correlation coefficient	
		Speaking tests from	Vocabulary tests	Vocabulary size	Vocabulary depth
Milton et al., 2010	30 EFL learners	IELTS	self-developed test	0.71	0.35
Shi, 2012	32 EFL learners	IELTS	VLT, WAT	0.816	0.843
Zhang, 2015	179 sophomores	TEM4	VLT, PLT	0.44	0.39
Guo, 2017	39 freshmen	Self-developed test	VLT, WAT	0.726	0.730

Notes: PLT for Productive Levels Test (Laufer & Nation, 1999); the correlation coefficient ranges from -1 to 1, the greater the coefficient, the closer the correlation.

Relationship between vocabulary knowledge and reading

It was proved that reading has a close correlation with vocabulary knowledge from the findings of the research (Hou, 2016; Li, 2012; Song, 2014; Wang, 2010). These results mean that students' reading would be much improved with increasing vocabulary knowledge. Table 2.4 below illustrates the studies by participants, instruments, and correlation coefficients.

Table 2.4 The research on the relationship between vocabulary and reading

Studies	Participants	Instruments		Correlation coefficient	
		Reading tests from	Vocabulary tests	Vocabulary size	Vocabulary depth
Wang, 2010	146 sophomores	TEM4	VLT, WAT	0.853	0.691
Li, 2012	115 freshmen	CET4	VLT, WAT	0.495	0.284
Song, 2014	69 freshmen	PRETCO	VLT, PLT	0.73	0.63
Hou, 2016	188 sophomores	TOEFL	VLT, PLT	0.775	0.765

Notes: PRETCO for Practical English Test for College in China; the correlation coefficient ranges from -1 to 1, the greater the coefficient, the closer the correlation.

Relationship between vocabulary knowledge and writing skills

It was found that vocabulary knowledge positively affected writing performances based on the following studies: Chen (2011); He (2012); Hou (2016); and Milton et al. (2010). They highlighted that the more vocabulary knowledge the students had, the better their writing performances became. Table 2.5 below shows the studies with regard to the participants, instruments, and correlation coefficients.

Table 2.5 The research on the relationship between vocabulary and writing

Studies	Participants	Instruments		Correlation coefficient	
		Writing tests from	Vocabulary tests	Vocabulary size	Vocabulary depth
Milton et al., 2010	30 EFL learners	IELTS	self-developed	0.766	0.44
Chen, 2011	69 high school students	CEE	VLT, WAT	0.553	0.572
He, 2012	70 sophomores	TEM4	PLT, WAT	0.495	0.284
Hou, 2016	188 sophomores	TOEFL	VLT, PLT	0.69	0.799

Notes: CEE for College Entrance Exams of China; the correlation coefficient ranges from -1 to 1, the greater the coefficient, the closer the correlation.

Relationship between vocabulary knowledge and language proficiency

It was claimed by researchers that vocabulary knowledge played a greatly facilitating role in enhancing language proficiency (Huang, 2003; Liu, 2016; Milton et al., 2010; Zhen, 2007). They stated that students' language proficiency was greatly increased when they acquired more vocabulary. Table 2.6 below demonstrates the research in terms of the participants, instruments, and correlation coefficients.

Table 2.6 The research on the relationship between vocabulary and proficiency

Studies	Participants	Instruments		Correlation coefficient	
		Proficiency tests	Vocabulary tests	Vocabulary size	Vocabulary depth
Huang, 2003	90 sophomores	CET4	VKS	N/A	0.872
Zhen, 2007	50 juniors	TEM4	VLT, VKS	0.357	0.453
Milton et al., 2010	30 EFL learners	IELTS	self-developedtests	0.68	0.55
Liu, 2016	127 sophomores	CET4	VLT, WAT	0.729	0.619

Notes: The correlation coefficient ranges from -1 to 1, the greater the coefficient, the closer the correlation.

In brief, vocabulary knowledge has a strong correlation with the four skills

and language proficiency based on the research above. This means that the more vocabulary students have, the more likely it is that they will perform better in the four skills and among various language proficiency tests. Also, the results above indicate that improving vocabulary is indispensable to developing good performances in language skills as well as language proficiency.

2.3 EFL Vocabulary Teaching and Learning in Chinese Universities

EFL vocabulary has been given little attention in Chinese universities. It was found that many university English teachers care little about vocabulary and believe that vocabulary learning should be done independently by students before or after the English class (Liu, 2018; Yang, 2013; Yang, 2018). He et al. (2017) explained that English teachers of Chinese universities have to distribute time to teach listening, speaking, reading, and writing skills within a limited 3-hour period per week. Consequently, little time or attention from English teachers is given to vocabulary.

Next, even if some teachers come to realize the importance of vocabulary, they mainly use traditional wordlists to teach students vocabulary in the university EFL classroom. Wang (2014) discovered that word list-based teaching was the most typical EFL vocabulary teaching method from grade three of elementary school to university. Similarly, English teachers mainly rely on the wordlists in English textbooks to teach vocabulary by directly translating without any context being given and then learners read after the teacher (Liu, 2015). This typical word list-based teaching may greatly influence students' methods of learning vocabulary. Such an influence has been confirmed in a survey by Zhang (2008), who found that reciting wordlists was ranked

the most frequent vocabulary learning strategy among Chinese university students.

Under such teaching conditions, it is not surprising to find that vocabulary levels are low among Chinese college students. Wang (2010) revealed that the average size conccerning receptive as well as productive vocabulary among Chinese non-English major sophomores was 3, 174 words and 1,142 words, respectively. Later, Cai (2012) conducted a large-scale survey of vocabulary size covering 36 universities in 21 provinces of China with 6,625 first-year students. The results illustrated that the number of mean vocabulary size from university learners was 2,899 words. Furthermore, Tang and Yin (2015) demonstrated that the students' average size for receptive vocabulary and productive one was 3,945 and 3,045, respectively, among 76 non-English major freshmen. The vocabulary size of Chinese university students can be recognized as insufficient if it is compared with the requirement of 4,500 words for passing CET4 in China (Yang, 2018) or the necessity of an 8,000-9,000 word-families to be competent in different English skills (Nation, 2006; Schmitt, 2010).

2.4 Vocabulary Learning Incidentally and Intentionally

Nation (2001) generally categorized vocabulary learning into two categories: learning vocabulary incidentally and learning vocabulary intentionally. Incidental vocabulary learning refers to the process of learning vocabulary unconsciously without attending to an individual word (Paribakht & Wesche, 1999). While intentional vocabulary learning is for learners to learn words consciously and on purpose, such as reciting a list of words from textbooks or vocabulary books (Barcroft, 2009).

2.4.1 Incidental Vocabulary Learning

Many studies examining differences between 2 approaches of learning vocabulary were reviewed by Krashen (1989), who found that learning vocabulary incidentally would make learners achieve more words than intentional vocabulary learning did since "words in natural texts are encountered in a variety of contexts, which helps readers acquire their full semantic and syntactic properties" (p.450). This claim is also supported by the following researchers: Coady and Huckin (1997); Gass, (1999); and Nagy and Herman (1987).

However, the disadvantages of incidental vocabulary learning in EFL settings cannot be ignored. To learn new words in the contexts, such as reading context, the prerequisite is that a learner's vocabulary coverage of a text needs to be at least 95%-98% for adequately comprehending the text (Hirsh & Nation, 1992; Hu & Nation, 2000; Laufer, 1989; Liu & Nation, 1985; Nation, 2001). This means that the 3,000-word family at the minimum is needed for learners to understand the text independently (Coady, 1997; Laufer, 1989). Nevertheless, Nation (2006) argued an even higher threshold of 8,000-9,000 word families. Therefore, it is unlikely for learners with small vocabulary size to learn new words through contexts. Besides, Krashen (1987) found that learners must have already mastered a substantial core vocabulary for the settings to become the kind of "comprehensible input" that can facilitate incidental L2 vocabulary learning. Furthermore, the researchers (Hulstijn, 1992; Mondria & Wit-de Boer, 1991; Nation, 1982) pointed out that contextual information in the texts was puzzling sometimes which made EFL/L2 learners difficult to infer the correct meanings of strange words. Also, empirical studies of incidental L2 vocabulary learning employing texts yielded little favorable vocabulary gains (Elgort & Warren, 2014;

Zahar, Cobb, & Spada, 2001).

2.4.2 Intentional Vocabulary Learning

Intentional vocabulary learning is practical and necessary, especially in foreign language learning. Laufer (2003) revealed that learners could memorize L2 words' meanings better by being involved in word-focused tasks than with texts. Besides, Rosalia (2012) showed that the process of incidental vocabulary learning was slower, and the words to be learned were unpredictable in what time, or to what degree. Nevertheless, the process of intentional vocabulary learning is direct and fast, which could improve vocabulary learning. Besides, Nation (2013) argued that foreign language learners could not master a second language as they learn their mother tongues because of time shortage, millions of vocabulary items, and lacking of native language environment. Moreover, intentional vocabulary learning can fully activate students' noticing. During the process of intentional vocabulary learning, noticing can be activated by various ways, such as a word list learning, learners' discussion of words' meanings, words' elaboration, or words' spelling (Nation, 2013). Moreover, the positive influences of noticing on learning vocabulary were mentioned by the studies (Boers et al., 2006; Laufer & Shmueli, 1997; Ramachandran & Rahim, 2004). Finally, the proponents of intentional vocabulary learning claim that learners can keep a lot from what words they pay attention to in their minds (Laufer, 2003; Nation, 2007, 2013).

Therefore, intentional vocabulary learning is selected as the way of learning vocabulary for the tudy. Given the curriculum arrangement in the 2019 academic year, the college English course for the non-English major freshmen in the target university lasts for two hours a week, and no class time is specially arranged for students' vocabulary learning. Besides, the students also pay little attention to vocabulary outside

the classroom (Zhang, 2008). As a result, they only pick up a few words by luck in the classroom. Next, the students stay in China all the time, not at the original states where native English language is used, and probably have no friends to practice English outside the classroom. This situation is further verified by Wei (2018), who found that Chinese EFL students do not equip with the advantages as first language speakers hold: learning words, phrases, their usages, and grammar by exposing themselves to the input almost anytime anywhere. Thus, it is almost unlikely for EFL learners to acquire much vocabulary incidentally outside the classroom. Thirdly, the vocabulary size of non-English major newcomers in the target university is around 2,000 words, which makes it almost impossible to implement incidental English vocabulary learning (Coady, 1997; Laufer, 1989; Nation, 2006). Under these circumstances, the intentional vocabulary learning is applied in the present study.

2.5 Vocabulary Retention

Vocabulary retention is defined by Maryam and Ahmad (2017) as the ability to remember or retain vocabulary in the memory. It has been shown that there is a close relationship between human memory and the mental ability to remember or retain information (Ellis, 1997; Stevick, 1996). Additionally, Ramezanali (2017) stated that memory is the mental capacity to retain, store, and retrieve past events, impressions, and facts.

Three Types of Memory Zhang (2004) states that memory would be separated into 3 types: sensory memory, short-term memory, and long-term memory, relying on its lasting time. Sensory memory is “the shortest-lived memory that lasts for

milliseconds to a few seconds" (Zhang, 2004, p.1). "When the information lasts from several seconds to a few minutes, the memory is then called short-term memory" (Zhang, 2004, p1). Short-term memory is responsible for allocating a limited amount of attention and temporarily holding information available for processing with limited capacity (Gathercole & Baddeley, 1993; Preston et al., 2010). In contrast, long-term memory lasts forever (Zhang, 2004). Sweller and Chandler (1994) indicate that there is no limitations for information storage capacity in the long-term memory.

Three phases of memory Ramezanali (2017) claims that there are three main phases in information processing and retrieval of memory: (a) encoding or registration, which entails receiving, processing, and the combining of received information; (b) storage of information, which encompasses creating a permanent information recording; and (c) recalling or retrieving, which includes getting back the maintained information in response to some cues for use in a process or activity.

Spacing effect According to Kang (2016), the first study and subsequent review being spaced over time often results in learning better than the massive repetitions (the total time length being equal for both situations). This phenomenon is called the spacing effect or distributed practice effect. Also, the spacing effect in improving learning memory is better than massed repetitions has been demonstrated in the studies (Bird, 2010; Carpenter et al., 2012; Cepeda et al., 2006; Namaziandost et al., 2019; Rogers, 2015, 2017; Rohrer, 2015; Serrano & Huang, 2018).

Concerning vocabulary retention, Kachroo (1962) found that learners could retain new words by repeating the words seven times or more. Next, it was claimed that vocabulary retention required at least six or seven repetitions (Crothers & Suppes, 1967).

Furthermore, it was recommended that learners needed to meet one word for five to sixteen times for acquiring it thoroughly, and frequent re-encountering of the word was crucial for their keeping the word in long-term memory (Nation, 1990, 2001). Furthermore, Oxford (1990) and Schmitt (2008) revealed that learners should re-encounter a word seven times for retention by intervals of fifteen minutes, an hour, two hours, one day, 4 days, a week, and 2 weeks after the first time learning. According to Daloğlu et al. (2009), vocabulary can be stored in long-term retention when learners encounter the strange vocabulary for three times at least. Serrano and Huang (2018) found that reading the passage one time a week for five successive weeks (spaced practice) led to a longer retention of target words than reading it once every day for five successive days (intensive practice).

Ebbinghaus (1885) examined the information forgetting rate with time passing by, as shown in Figure 2.9 below. It depicts the rate at which information is forgotten over time, if there is no attempt to retain it, and demonstrates that information could be stored for a long term with little loss after four weeks. Later, the findings were confirmed concerning rapid forgetting and information retention in much research (e.g. Bahrick, 1992; Conway et al., 1992; Farjami & Aidinlou, 2013; Thalheimer, 2010). One effective way to prevent forgetting and improve retention is to space reviews of the information learned, which was proposed by the following researchers: Averell and Heathcote (2011); Dongale et al. (2018); Hu et al. (2013); Murre and Dros (2015); Namaziandost et al. (2019); Serrano and Huang (2018).

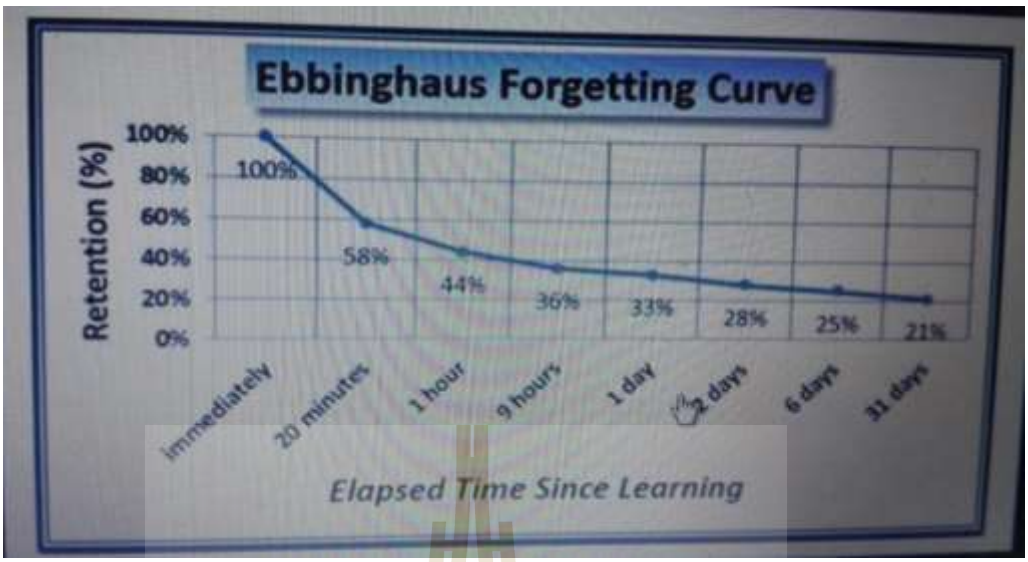


Figure 2.9 Ebbinghaus Forgetting Curve (Ebbinghaus, 1885)

Combined with the memory theory above and the curriculum schedule for the freshmen in the academic year 2019, the students reviewed the target words four times in one week at intervals of 9 hours, one day, 2 days and six days after their first-time encounter was arranged for the present study. Although repetitive vocabulary learning at intervals of 15 minutes, one hour, 2 hours seems to be reasonable based on Ebbinghaus' (1885) Forgetting Curve, it is almost impossible for the freshmen to review the vocabulary at the intervals above, for they have a 3-6 hours' course to attend each day for five successive days per week. Therefore, spaced review of vocabulary at intervals of nine hours, 1 day, two days, and six days after their first-time learning was considered appropriate and practical for the freshmen in the present study. Secondly, to measure vocabulary retention, a delayed-post-test was done out 4 weeks after the post-test in the study. The reason for the 4-week interval between the 2 tests above was that the information kept in the human memory is lost little and can be stored stably in long-term retention (Ebbinghaus, 1885).

Techniques for improving vocabulary retention For enhancing vocabulary retention in long-term memory, several techniques are provided, which aim at the three types and phases of memory (Ramezanali, 2017; Zhang, 2004) above. Firstly, to arouse learners' noticing of the target word and encoding it in their minds, imagery and verbal representations of the word are presented. Also, recall can be enhanced by showing the word with dual channels of visual and verbal forms rather than showing it in a single channel, which would find support from dual coding theory (Clark & Paivio, 1991) and from the cognitive theory of multimedia learning (Mayer, 2014). Next, according to Groot (2000), the contexts, even the sentence context, can better facilitate learning and retention of the word than without any context.

Finally, retrieval practice, also known as the practice effect, measures not only the student's knowledge but also his/her strengths (Karpicke & Roediger, 2008). Whenever information is retrieved or recalled from memory once, then the knowledge is strengthened, as knowledge recalling practice can enhance one's ability of getting it back in the future (Karpicke & Roediger, 2008; Karpicke & Zaromb, 2010). According to Brown et al. (2014), repeated retrieval makes memories more durable and creates knowledge that can be retrieved more efficiently in multiple settings. Additionally, Carey (2015) stated that when knowledge is retrieved successfully, neural paths to the information were strengthened, and additional paths formed. As a result, the recall of the information is faster and easier in the future. Many studies have revealed that information that was practiced through retrieval was better retained than those that were not (e.g. Barcroft, 2006; Carrier & Pashler, 1992; Reimer, 2019; Rickard & Pan, 2018; Roediger & Butler, 2011).

2.6 Mobile-Assisted Language Learning

According to Church and Oliver (2011), the term "Mobile" is associated with "on-the-move". Based on Brown et al. (2014), the term "Mobile" includes several aspects that refer to devices for communication, to the ones for delivering learning/ training, and to the movement from the fixed learning to portable learning.

Mobile learning (M-Learning) is a widely accepted term for using mobile technologies to assist learning. Rajan and Kumar (2014) define M-Learning as "the acquisition of knowledge and skill through using mobile technology anytime, anywhere that result in alteration of behavior" (p.161). The cardinal aspect of M-Learning, which separates it from any previous form of learning is that learning is no longer confined by location and time (MacCallum, 2009). Learning anywhere and anytime is made possible by the portability of mobile devices as well as mobile technologies (Chen & Hsu, 2008; Peters, 2007; Soleimani et al., 2014). Some studies (e.g. Geddes, 2004; Hockly, 2013; Kukulska-Hulme & Shield, 2008; Sandberg et al., 2011) have found that M-Learning can assist learners to learn different subjects at the time and place they prefer, also allowing for both informal and formal learning.

According to Kukulska-Hulme and Shield (2008), the sub-area of M-Learning, where mobile technologies are used exclusively for assisting language learning, is defined as mobile-assisted language learning (MALL). The term MALL describes "an approach to language learning that is assisted or enhanced through the use of a handheld mobile device" (Valarmathi, 2011, p.2). Viberg and Grönlund (2012) claim that MALL refers to using mobile technologies as supplements for making language learning better.

Later, MALL was redefined by Kukulska-Hulme (2013) as the use of "mobile technologies in language learning, especially in situations where device portability offers specific advantages" (p.3701). Chen (2013) defines MALL as a formal or an informal learning of foreign languages with the aid from mobile devices.

In the present study, MALL is regarded as one process of learning languages with the help from mobile devices, mobile technologies, or learners' mobility.

Advantages of MALL

Kukulska-Hulme (2009) claimed that the differing advantages of MALL from learning language by a traditional way are the portability and the mobility, creating countless learning chances. This viewpoint is supported by Jee (2011), who stated that portability and easy access to the internet through mobile devices enable learners to be exposed to second or foreign language resources anytime and anywhere, which would facilitate language learning.

The second advantage is that mobile devices can deliver information ubiquitously through mobile technologies (Younus, 2014). Many studies find that mobile devices are quite convenient for students' usage no matter in or outside the classroom and they facilitate remote participation in language learning (e.g. Godwin-Jones, 2008; Huang et al., 2012; Kukulska-Hulme, 2006; Miangah & Nezarat, 2012).

The third advantage of MALL is the potential of learning language personally, spontaneously, and informally based on many studies (e.g. Jaris & Krashen, 2014; Olmsted & Terry, 2014; Stockwell & Hubbard, 2013; Viberg & Grönlund, 2012). In the next section, the research on MALL is reviewed.

2.6.1 Research on Mobile-Assisted Language Learning

The research on MALL is reviewed by means of different impacts of MALL on listening (Azar & Nasiri, 2014; Kim, 2013; Zhang, 2014), reading (Hazaea & Alzubi, 2016; Leila & Mehry, 2016), speaking (Ana & Anna, 2015; Hadi & Emzir, 2016; Saran et al., 2009; Sun et al., 2017), and writing (Al-Wasy & Mahdi, 2016; Chen et al., 2017; Ebadi & Rahimi, 2017).

Effects of MALL on listening

To demonstrate the effects of MALL on EFL listening skills, Kim (2013) conducted an empirical study among Korean non-English major students. Twenty students from the experiment group listened to authentic listening materials twice a week through a smart-phone app of an English radio broadcast out of class for ten weeks while those in the control group were not. On week 14, all participants took the post-test of TOEIC like in the pretest. What was found was that the experiment group students obtained higher marks on the listening section than those peers of the control group did. Besides, it was concluded that it could be effective for improving EFL learners' listening by apps of smart phones outside the classroom.

Azar and Nasiri (2014) examined the effects of MALL on listening skills in an Iranian EFL setting. Thirty-five EFL college students formed an experiment group, and thirty-five counterparts formed a control group at random. The experiment lasted for a period of 16 sessions in one term, and the single difference between them above was that the experiment group used audiobooks to assist their English listening learning outside classroom, but another group did not. As a result, in the post-test, the experiment group got higher mean than another group, and impacts of audiobooks on the mobile

phone on listening comprehension were shown to be statistically significant.

Zhang (2016) explored if employing mobile technology could facilitate EFL students' listening ability. 120 Chinese university students were divided randomly into two groups: one experiment group (n=60) practicing extensive listening through mobile phone apps after class and the other control group (n=60) practicing listening via the traditional method of listening to a CD-ROM after class. After a ten-week experiment, all participants took a listening comprehension in a post-test. As a result, on the listening comprehension post-test, the app group outperformed the control group greatly.

In short, the mobile apps or audiobooks of mobile phones can be more effective than traditional methods in improving EFL learners' listening skills outside the classroom. Therefore, mobile technologies can be useful instruments in fully using students' after-class time to enhance their listening.

Effects of MALL on reading

Hazaea and Alzubi (2016) explored what effects on EFL learners' reading through mobile technologies among Saudi Arabian college EFL students. An EFL reading class of 30 college students was encouraged to use their mobile phones to help them with reading inside and outside the classroom. During the treatment of fourteen weeks, the classroom observations, self-reflection journals, and semi-structured interviews were used to collect data. It was highlighted that the students' reading practices improved considerably after using their mobile phones. And it was proposed that in a Saudi Arabian EFL context, shifting from the traditional reading way to a stress-free reading way in MALL environment could be conducted gradually.

Leila and Mehry (2016) conducted a study for probing the impact of MALL on learners' reading comprehension by randomly assigning twenty students to each group: one control group and one experiment group in an Iranian EFL context. During the twenty-session experiment, the control group did reading practice by a pencile and a paper, but the experiment group did the same by mobile phones. It was found that MALL had significantly positive influences on learners' reading comprehension of the experiment group.

These studies found that MALL could enhance learners' reading comprehension more effectively than a traditional way of paper and pencil whether it was conducted inside or outside the EFL classroom (Hazaea & Alzubi, 2016; Leila & Mehry, 2016).

Effects of MALL on speaking

Saran et al. (2009) investigated the potentials and effectiveness of using mobile phones on EFL learners' pronunciation using a mixed method. Twenty-four university EFL learners at elementary level were selected as participants and then separated into three groups with a different mode: handouts, web pages, and mobile phones. For four weeks, the students attended classes regularly with one mode (mobile phones/web pages/handouts) to improve their pronunciation. It was showed that the mobile phone group increased by 11.94% and the other two groups increased by 6.81% for pronunciation performances. Furthermore, the interviewees responded that they holding mobile phones preferred to save and review information for pronunciation practice later than their peers in the other two groups. The researchers proposed that using mobile phones could increase learners' motivations in learning and reviewing

English materials.

Ana and Anna (2015) explored the effects of MALL on EFL students' accuracy and fluency in oral production with a mobile app named VISP (Videos for Speaking) among Spanish college EFL students. 16 Spanish college EFL learners with an intermediate English proficiency were chosen to learn how to use the mobile app for practicing their speaking whenever it was convenient. As a result, the accuracy and fluency of all the students were improved after using the mobile app VISP. Also, they all declared that the mobile app VISP made them realize the significance of accuracy in using vocabulary (100%), of considering the audience (100%) as well as their language learning (100%), and 90% of students believed that the mobile app helped them realize the close relationship between the way of communication and the way of perceiving things (90%).

Hadi and Emzir (2016) carried out an action research to investigate how to improve English speaking proficiency via the MALL among Indonesian EFL college students. Thirty second-year English major students in an Indonesian university participated in the research in three cycles in which they were required to use smartphones to practice speaking and find help. The result was that an improvement in speaking could be seen from the increased scores in the preliminary stage, the first cycle, the second cycle, and the third cycle, respectively. In addition, MALL increased the students' involvement in speaking, which was characterized by the responses they gave to teachers, the questions they asked, and finding answers via their smartphones independently.

Sun et al. (2017) probed into impacts of MALL on English speaking among

young Chinese EFL learners. One first-grade EFL class in an elementary school was named as the experiment group and the other one as the control group. The experiment group used social-networking sites (SNS) on mobile phones to practice English speaking, while the control group did not. In the speaking post-test, achievements concerning English fluency with the experiment group were more substantial. The reason for this may be found from one specific strength of SNS for mobile learning could situate learners to speak with low or zero stress.

In brief, MALL can positively facilitate EFL learners' pronunciation or speaking by increasing their motivation and review (Saran et al., 2009), by improving their awareness towards the importance of vocabulary accuracy, their audience and the method of communication (Ana & Anna, 2015), by forcing them to become more involved in asking questions (Hadi & Emzir, 2016), and by enabling them to speak more in low-stress and situated contexts (Sun et al., 2017).

Effects of MALL on writing

Al-Wasy and Mahdi (2016) explored the influences of mobile phones' usage on writing in a Saudi Arabian EFL context. During the four-week treatment, the students had one session of two hours every week. In the session, one of the four areas in the mobile app White Smoke: grammatical errors editing, spelling errors editing, punctuation errors editing, and capitalization errors editing, was taught. After the treatment, in the fifth week, the subjects had to compose a paragraph and then edit their paragraphs by using the traditional method of self-editing. In the sixth week, they wrote down a paragraph and edit their paragraphs by using the mobile app. Every participant

had to submit two drafts (first and last) of his paragraph using the traditional method and the mobile app. According to the analysis, the student's ability in self-editing improved two aspects: grammar and punctuation after using the mobile app. This study encouraged EFL teachers to engage students in as many self-editing activities as possible employing MALL.

Ebadi and Rahimi (2017) examined the impact of using MALL on learners' writing performance among Iranian college EFL students. 60 students comprised a control group and another 60 peers an experiment group. The experiment group received the writing instructions via a mobile phone app as a writing enhancement, but the control group was instructed with a traditional way. An independent-samples t-test detected a huge difference in writing performance between the two groups. Thus, mobile-assisted writing instructions can positively affect students' writing and results in better performance in writing and spelling. The reasons may be due to factors such as increased motivation in using the mobile app, the interesting and appropriate design of the mobile app, and the more time that students spent on their cell-phones than their counterparts in the control group.

Chen et al. (2017) explored how using scaffolding influenced young English Language Learners' (ELLs) writing skills through an app (Penultimate) on iPads in the USA. Five ELLs (2 boys and three girls, aged 9-13) participated in the four week' writing project assisted by mobile technologies. During the narration writing, the participants composed one pre-essay with paper and pen. A week later, they finished the post writing tasks with a writing app: an iPad2 and Penultimate. After all tasks were

finished, an informal interview was conducted for every particiapnt to share his thoughts or feelings withing fifteen minutes. The findings suggested that the English language learners' writing ability and learning motivation were much improved with the mobile technologies.

To sum up, MALL would enhance EFL students' writing abilities positively by increasing their engagement in writing (Al-Wasy & Mahdi, 2016) and arousing their motivation and interest in writing (Chen et al., 2017; Ebadi & Rahimi, 2017), whether they are young students or university students. Thus, the research reviewed above supports the use of MALL to improve EFL learning with regard to listening, reading, speaking, and writing skills.

2.6.2 Students' Perceptions of Mobile-Assisted Language Learning

The definition of "perception" is "the ability to see, hear, or become aware of something through the senses" from the Oxford dictionary of American English (2014). As for the perceptions of MALL, its main components include attitudes towards using, continued intention to use, perceived convenience, perceived ease of use, and perceived usefulness in terms of Chang et al. (2012) and Davis (1989).

Steel (2012) explored how using mobile apps affects EFL students' language learning. It was found that students perceived mobile apps as convenient, portable, and on-the-go learning. Also, students exhibited more content with low cost or free mobile apps.

Kim and Altmann (2013) examined the influences of employing mobile devices on learners' perceptions. 53 MA students for TESOL were surveyed, and it was disclosed that learning language through mobile devices offered them a new learning experience.

Faqe (2015) investigated how mobile apps influenced students learning English in a Japanese university. As a result, most students had positive perceptions of learning English with mobile apps, which found support from the studies (Dashti & Aldashti, 2015; Fujimoto, 2012; White & Mills, 2012).

Zhang (2016) explored Chinese students' perceptions of MALL with two instruments: an interview and a questionnaire. According to the responses from the questionnaire, 88% of the participants regarded mobile-assisted listening learning as quite convenient. 85% of participants considered that usage of mobile apps indeed stimulates them to learn English and to practice more (74%). Also, they reported that using mobile apps increased their interest in English, changed their attitude towards learning, and developed their confidence. From the interview responses, the respondents showed that they were willing to make more efforts in listening via a mobile app, and MALL also enabled them to control their learning better.

However, different perceptions of MALL were identified. In order to find students' in-depth perceptions of mobile assisted learning, Barbour et al. (2014) collected data through a survey and an interview with six students, and revealed that they dislike learning with mobile phones. In addition, Dukic, Chiu, and Lo (2015) examined how university leanrers of Hong Kong and Japan perceived smartphones as learning tools. They found that leanrers employed smartphones mainly as entertainment, socializing, communication, and quick searching for their information needs in daily life. Moreover, the students commented that it was useful and easy for them to employ smartphones to do simple tasks: taking notes, assignments' discussion with peers, searching course materials and information. Nevertheless, they perceived that it was

not suitable for using smartphones to do academic writing and reading with needing much attention.

Furthermore, the small size of the smartphone screen was considered as an obstacle for using a smartphone to learn a language. The research disclosed that the size of a smartphone screen was too small for learners to write and read academic papers concentratedly (Stockwell, 2010; Woodcock et al., 2012). Additionally, most students found that they used smartphones mostly on-the-go and outside the classroom, but it would not suitable for students' serious learning in the environment above (Faqe, 2015; Godwin-Jones, 2011; Steel, 2012). So they were more willing to do academic work with computers or by a paper-based method in a quiet environment (Stockwell, 2008).

2.6.3 Research on EFL Vocabulary Learning and Retention via MALL

The research on the effects of MALL on EFL vocabulary learning or retention is reviewed with regard to the effectiveness of SMS (Alemi et al., 2012; Cavus & Ibrahim, 2009; Kim, 2011; Motallebzadeh et al., 2011; Ornprapat & Wiwat, 2015; Tatabaei & Goojani, 2012; Zhang, 2011), mobile phones (Azabdaftati & Mozaheb, 2012; Başoğlu & Akdemir, 2010; Nikoopour et al., 2014), WhatsApp (Basal et al., 2016; Bensalem, 2018; Dehghan et al., 2017; Jafari & Chalak, 2016), and self-developed mobile apps (Agca & Özdemir, 2013; Makoe & Shandu, 2018; Ou-Yang & Wu, 2017; Wu, 2015).

Short Message Service (SMS)

Cavus and Ibrahim (2009) explored the potential of using SMS to learn English words in an EFL context in Turkey by selecting 45 college non-English major freshmen as subjects. During the nine-day treatment, forty-five students received and

learned word pairs through SMS every half an hour daily between 9 a.m. and 5 p.m. The result of a paired-samples t-test demonstrated that students did better in the post-test than in the pretest ($p<0.05$).

Motallebzadeh et al. (2011) explored the effect of using SMS on mobile phones on English collocations' learning of Iranian EFL learners with forty college EFL students as subjects. During the five-week treatment, the experimental group of twenty students received and learned seven collocations with descriptions and examples through SMS twice a week outside the classroom while the control group with the other twenty counterparts received and learned the same number of collocations using a paper-based method in the classroom. After an analysis of the post-test, it was found that the SMS group students significantly achieved more than their peers of the paper-based group, indicating that using SMS exhibited a facilitating impact on English collocations' learning.

Kim (2011) probed into the impacts of employing SMS on English words' learning in a Korean EFL context by choosing sixty-two non-English major students as subjects. During the six-week treatment, the 21 students in the control group learned thirty English words only in class every week, while the 41 counterparts of two experiment groups got 2 text messages with the same number of target words through the SMS every week after class. Moreover, the difference between the first experimental group with 21 students and the second experimental group with 20 counterparts was related to interactivity. In detail, the first experiment group students only received and did not send any text messages back, while the second experiment group peers got and

sent texts to answer quizzes. With one-way ANOVA, it was found that there was a statistically significant difference in vocabulary achievements between the three groups, and the two experimental groups showed considerably more improvement in their vocabulary learning than the control group. Additionally, the second experiment group with interactivity via SMS achieved significantly higher means than those in experimental group one without it. Furthermore, according to the students' responses to the survey, the benefits of using SMS were listed as follows: repetition, easiness, immediate accessibility, learning words effectively in their spare time and without effort. Its drawbacks were also discussed, for example, students said it was almost impossible to read text messages in busy hours, it caused problems because of receiving many text messages at the same time, and it limited the saving capacity of their mobile phones.

Zhang et al. (2011) examined the effectiveness of EFL vocabulary learning and retention via SMS of mobile phones among Chinese college EFL students with 78 non-English major sophomores as subjects. During the twenty-six-day period, the experimental group with 40 students learned five English words every day via SMS after class, while the 38 counterparts received 130 words on paper sheets at the beginning and learned them in a self-regulated way outside the classroom. From the post-test, it was found that learners of experiment group attained more words than their peers of control group. However, by means of an analysis of the delayed post-test, little difference was detected in vocabulary retention between the two groups. According to the students' self-reports in the experimental group, the advantages of vocabulary learning via SMS were that it made full use of fragmented time, and it was also

convenient and motivating. The disadvantages were as follows: Firstly, the memory capacity of mobile phones was usually restrained for storing too many received words. Next, even worse, when messages were too many for the memory capacity, dysfunction would appear frequently. For example, phonetic symbols could not be operated on the phones. Thirdly, long messages were likely to be sent as separate shorter ones. When the number of words in a message exceeded the limitation, the system would divide the message into separate mini-messages. Furthermore, those mini-messages were received usually out of order, which confused and annoyed the students. Finally, reviewing the text messages could be troublesome, because it would consume students' much time to find previous messages, especially difficult for those receiving many different kinds of messages every day.

Alemi et al. (2012) conducted an investigation on the impacts of SMS on learning vocabulary as well as its retention by choosing forty-five Iranian college non-English major newcomers as subjects. During the sixteen-week treatment, 28 students in the experimental group received and learned ten headwords with definitions (both in L1: Persian and L2: English) and example sentences via SMS every session in class for two sessions a week. In contrast, 17 students in the control group learned the same headwords by looking dictionaries up independently during the same period in class. The results showed that the mean (M=25.17) of the post-test got by experiment group was larger than that (M=22.64) from control group, but little difference between two groups was seen. However, the delayed post-test demonstrated a significant difference between them, suggesting that the SMS group retained better than the control group.

Tabatabaei and Goojani (2012) explored the impact of using SMS on mobile phones on vocabulary learning by selecting 60 Iranian senior high school students as subjects. During the six week treatment, thirty students sent a message with target words to the teacher, and the teacher provided them with feedback through SMS. Next, the students also had to deliver one message with a sentence to three partners some time before they came to class and they waited for their partners' feedback, if any. The other 30 counterparts finished the same assignments but on paper. From an analysis of the post-test, the experiment group obtained a significantly better result on the vocabulary than the control group.

Ornprapat and Wiwat (2015) examined the effects of using SMS on mobile phones to complete vocabulary exercises on vocabulary acquisition in the Thailand EFL context. Forty freshmen were assigned to the experimental group and 40 counterparts to the control group. During the six week treatment, the control group wrote vocabulary exercises on paper, including 100 words in class, while the other group did those vocabulary exercises through SMS, then sent them to the teacher's mobile phone after class. From the analysis of the post-test, the vocabulary means of the SMS-based group were significantly higher than that of the paper-based group.

To sum up, the studies found that using SMS on mobile phones was helpful for learning EFL vocabulary inside or outside the classroom in different EFL contexts (Alemi et al., 2012; Cavus & Ibrahim, 2009; Kim, 2011; Motallebzadeh et al., 2011; Ornprapat & Wiwat, 2015; Tabatabaei & Goojani, 2012; Zhang et al., 2011). Next, most of the subjects in the studies are college EFL students from all majors. Only one study

(Tabatabaei & Goojani, 2012) comprises senior high school students. Thirdly, what most studies focused on were only the effects of SMS on vocabulary learning. Only two studies not only investigated the impact of applying SMS to vocabulary learning but also to vocabulary retention in the long term (Alemi et al., 2012; Zhang et al., 2011). However, they obtained contrary results in the post- and delayed post-test. Yet the drawbacks, such as the cost of SMS, limited memory capacity, and dysfunction, as mentioned in the studies of Azabdaftati and Mozaheb (2012) and Zhang et al. (2011) should not be overlooked when using SMS to assist vocabulary learning.

Mobile phones as platforms

Başoğlu and Akdemir (2010) compared the effects of learning vocabulary by way of paper flashcards and of mobile phones among Turkish college EFL students. During the six week period, the experimental group of 30 students learned about 1000 words outside the classroom through the app, ECTACO Flashcards on the mobile phone, while the control group of another 30 counterparts learned the same number of words with paper flashcards after class. From an analysis of the post-test, mobile phones did better on enhancing EFL learners' vocabulary than paper flashcards.

Azabdaftati and Mozaheb (2012) explored what method to assist vocabulary learning more effectively: a mobile phone-based method or a flashcard-based method among Iranian university EFL students. During the seven weeks, forty English major freshmen in the experimental group learned about 1,200 new words through the app SRS (Spaced Repetition System) and SMS on the mobile phone while forty peers learned the same words by paper flashcards inside and outside the classroom. It was

found that the students in the experimental group achieved more than the counterparts in the control group on the post-test, suggesting that mobile technologies (the app SRS and SMS) are more effective in assisting students' vocabulary learning than paper flashcards.

Nikoopour et al. (2014) explored the effects of vocabulary learning when mobile phone-based, computer-based, and paper-based flashcards served as tools among Iranian college English major students. During the ten week treatment, 36 students learned seventy words from TOEFL & IELTS every week in paper-based flashcards inside the classroom, 36 counterparts learned the same words through online flashcards of the computer inside the classroom, while 37 peers learned the same words via mobile phone-based flashcards outside the classroom. Using the one-way ANOVA test on the post-test, the mobile phone-based group outperformed the computer-based group in the post-test on vocabulary acquisition. Compared with the computer-based group, students from the paper-based group achieved better results. However, there was no significant difference in the post-test between the mobile phone-based group and the paper-based group. It might have something to do with the inconvenience of not taking flashcards everywhere, while the mobile-based group students and the paper-based group ones benefitted a lot from the portability and ubiquity.

To summarize, mobile phones used as platforms for improving vocabulary teaching and learning have been approved inside/outside the classroom compared to the paper-based methods in the studies (Azabdaftati & Mozaheb, 2012; Başoğlu & Akdemir, 2010). Nevertheless, Nikoopour et al. (2014) found that the mobile phone-based method did not demonstrate any more benefits than the paper-based method in assisting

vocabulary learning.

WhatsApp and self-developed mobile apps

Basal et al. (2016) investigated the role of WhatsApp of mobile phones in learning vocabulary among Turkish EFL students by choosing 50 first-year college students as subjects. During the four week treatment, the experimental group of twenty-five students received and learned ten idioms with meanings, example sentences and exercises through WhatsApp in the classroom every week, while the control group of another twenty-five counterparts received and learned the same idioms using a paper-based method in the classroom. From an analysis of the post-test, the experiment group obtained better results in vocabulary tests than the control group, which suggested that teaching idioms for EFL learners was effective by WhatsApp.

Jafari and Chalak (2016) explored how WhatsApp affected vocabulary learning by selecting 60 Iranian junior high school students as subjects. During four weeks, 30 students in the experimental group received vocabulary instructions through WhatsApp four days a week, while 30 counterparts in the control group were taught the same vocabulary inside the classroom by the traditional paper-based method. From an analysis of the post-test, it was found that the students with WhatsApp performed better on vocabulary acquisition than their counterparts in the control group and that there was not a substantial difference on their performances between females and males students.

Dehghan et al. (2017) studed how WhatsApp impacted vocabulary teaching in an Iranian EFL context by selecting 32 teenaged students as subjects. The experimental group of 16 students received instruction by means of a vocabulary list

through WhatsApp on their smartphones, while the control group of another 16 counterparts received the same vocabulary list through traditional textbooks in the classroom. With an independent-samples t-test, it was found that few differences on vocabulary acquisition existed between 2 groups. According to the researchers, this might be attributable to several reasons. The first reason may be that students could not control their process of learning vocabulary because of WhatsApp nature with the flood of irrelevant or nonsensical messages, posts, links or chatting and listening to music, that easily distracted them from learning the vocabulary. The second reason could be related to the reputation of WhatsApp as an entertainment and communication app. According to Church and de Olivia (2013), social networks such as WhatsApp are assumed by many teachers and students as informal communication devices which are not suitable for formal learning in educational settings. Finally, the limited number of students and of words might impact the results' difference from two groups.

Bensalem (2018) explored the impact of WhatsApp on mobile phones on vocabulary learning in a Saudi Arabian EFL context with forty college students as subjects. During the six weeks, both groups were offered 120 words for six weeks to learn with 20 words per week. The experimental group of 21 students received word lists via WhatsApp, while the control group of 19 counterparts was given printed copies of the same word lists in class. From an analysis of the post-test, it was found that the WhatsApp group learned significantly more words than the control group.

Agca and Özdemir (2013) investigated how two-dimensional (2D) barcode technology affected vocabulary learning among Gazi college EFL students. During the

two week treatment, forty students were selected to learn 84 words independently in the classroom by scanning a 2D barcode on the pages of an English book with a smartphone that could display the words' definitions and images. Using a paired-samples t-test, the 2D barcode of mobile phones could greatly increase the students' vocabulary and facilitated their learning of new words.

Wu (2015) examined the effectiveness of a self-developed app on a smart-phone on learning EFL words among EFL students of China universities by selecting 50 non-English major sophomores as subjects. During the one semester experiment, students of 2 groups were taught 852 words as they appeared in the different units, the glossary and the Appendix Nf the students' textbooks during classes. The only difference was that the 25 students in the experimental group could review the words with the mobile app Word-Learning developed by the researcher, while the other 25 counterparts of control group could not access it. Later, it was demonstrted that leanrers of experimental group obtained higher scores in post-test than their control group peers.

Ou-Yang and Wu (2017) studied how employing a self-developed mobile app: MyEVA influenced vocabulary learning among university EFL students in Taiwan. 55 English majors and 53 non-English majors were selected as participants to learn fifty words from a TOEIC vocabulary list with the mobile app, MyEVA, in two weeks. Using a t-test and one-way ANOVA, it was found that the mobile app significantly enhanced the vocabulary acquisition of both majors, and achievements of English majors were greater than those from non-English majors.

Makoe and Shandu (2018) designed a smartphone app (VocUp) for

enhancing South African university EFL students' vocabulary learning in an open distance learning context. Firstly, they developed the app VocUp in terms of a design-based research methodology. Then, the app VocUp was tested among 29 first-year university students. According to 18 interviewees' responses, the results showed its benefits in vocabulary content, ease of use, being familiar with smart phone systems, and prompt feedback. Despite the benefits above, some difficulties were experienced, for example, problems with the phones, issues of the network connection, lacking knowledge of phone usage.

To summarize, WhatsApp is a social communication app. Language learners would often choose not to use or are very reluctant to use the target language via social communication apps for fear of not being understood by others (Alm, 2013; Chen, 2013). Furthermore, there are few studies (e.g. Agca & Özdemir, 2013; Makoe & Shandu, 2018; Ou-Yang & Wu, 2017; Wu, 2015) developing mobile apps for vocabulary learning, and what they focused on was only the impacts of mobile apps on vocabulary learning, but not on vocabulary retention. Additionally, the mobile apps above lack of theoretical support concering vocabulary learning and memory. Although there may be mobile apps for vocabulary learning in other countries, it is almost impossible for Chinese learners to connect to Google and get access to the apps due to the policy of the government for accessing to applications in overseas app stores. Therefore, in order to fill these gaps, a mobile app was developed based on four theories relevant to vocabulary learing as well as retention, and its effects were tested among Chinese EFL learners.

Conclusions on the Research about Mobile-Assisted Language Learning

Firstly, most of the studies have proved that to teach and learn vocabulary

can be better facilitated via mobile phones or mobile technologies compared to traditional methods of paper-based or textbook-based study inside/outside the classroom (Azabdaftati & Mozaheb, 2012; Başoğlu & Akdemir, 2010; Basal et al., 2016; Bensalem, 2018; Jafari & Chalak, 2016; Kim, 2011; Motallebzadeh et al., 2011; Ornprapat & Wiwat, 2015; Ou-Yang & Wu, 2017; Tabatabaei & Goojani, 2012; Wu, 2014). Secondly, the studies which explored learners' attitudes towards mobile-assisted vocabulary learning show that they held positive views, and such words as "convenient, effective, available, entertaining" are often used to describe their attitudes (Azabdaftati & Mozaheb, 2012; Agca & Özdemir, 2013; Başoğlu & Akdemir, 2010; Bensalem, 2018; Cavus & Ibrahim, 2009; Motallebzadeh et al., 2011; Nikoopour et al., 2014; Ornprapat & Wiwat, 2015; Tabatabaei & Goojani, 2012).

Gaps Firstly, some research studies showed that students did not perform better on vocabulary learning via MALL than their counterparts who used traditional methods of paper-based or textbook-based study (Alemi et al., 2012; Dehghan et al., 2017; Nikoopour et al., 2014; Zhang et al., 2011). However, these results were not consistent with the findings of most studies (e.g. Azabdaftati & Mozaheb, 2012; Başoğlu & Akdemir, 2010; Basal et al., 2016; Bensalem, 2018; Jafari & Chalak, 2016; Kim, 2011; Motallebzadeh et al, 2011; Ornprapat & Wiwat, 2015; Ou-Yang & Wu, 2017; Tabatabaei & Goojani, 2012; Wu, 2014).

Secondly, few studies have explored the effects of mobile technologies on vocabulary retention, but those that have studied retention obtained completely opposite results to each other (Alemi et al., 2012; Zhang et al., 2011). According to

Thornbury (2002), learning is, in fact, remembering. Thus, vocabulary learning is actually vocabulary retention. So for further understanding of the effects of mobile technologies, both vocabulary learning and vocabulary retention are included in the present study.

Thirdly, few researchers (Agca & Özdemir, 2013; Makoe & Shandu, 2018; Ou-Yang & Wu, 2017; Wu, 2015) have developed mobile apps especially for vocabulary learning, or showed their benefits in facilitating vocabulary learning, except that Makoe and Shandu (2018) did not explore the app's effectiveness. Nevertheless, EFL learners' perceptions of vocabulary learning via mobile apps were explored only by Agca and Özdemir (2013). Furthermore, according to Afzali et al. (2017) and Burston (2013), studies on the effects of self-developed mobile apps on EFL vocabulary learning are still rare in an EFL context, and EFL learners' perceptions of mobile apps need to be further explored.

The present study proposes to fill the gaps above. It also aims to use mobile apps as a means for improving vocabulary learning and retention, as well as to test its effects. In addition, the students' perceptions of mobile apps are explored, for their perceptions of the apps have a direct influence on their language learning (Yu, 2019).

2.7 Summary

Chapter two presents an overall picture of the present state of research on vocabulary learning and retention and the effectiveness of mobile apps for vocabulary use through a review of the literature related to a theoretical framework, vocabulary knowledge as well as retention, mobile-assisted language learning (MALL), and EFL

vocabulary learning and retention via MALL. Firstly, the theoretical framework is presented to provide theoretical support for the present study. Next, vocabulary knowledge, including vocabulary definitions, the two dimensions of vocabulary knowledge, and related research, are introduced. Then, incidental and intentional vocabulary learning are demonstrated and these are followed by vocabulary retention. Additionally, MALL is presented, and related studies on MALL are reviewed. Finally, the research on EFL vocabulary learning, as well as vocabulary retention via MALL, is presented and the present gaps are pointed out.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter introduces the methodology used in the present study. It starts with the research design, and then introduces the population and samples of the study, the research instruments, and the procedure of the experiment, which is followed by the data collection and the data analysis. Finally, it concludes with a summary.

3.1 Research Design

The current study aims to investigate the effects of using a mobile app on EFL learners' vocabulary learning and retention, and also to explore their perceptions of the mobile app.

According to Creswell and Creswell (2017), for an experiment in which only a convenient sample is possible, and when subjects are not randomly assigned, the procedure is called a quasi-experiment. The researchers (Charles & Mertler, 2002; Thomas, 2003; Wiersma & Jurs, 2005) agree that a quasi-experiment is a kind of experimental research for dealing with the relationship between cause and effect. It might compare outcomes for one group receiving program tasks with outcomes for another similar group not receiving program tasks (Moore, 2008). A quasi-experimental design is applied in the present study because the purpose of this research was to explore the effects of the mobile app on vocabulary learning, and two sample classes were

chosen based on convenience.

Furthermore, a mixed-method approach is employed in the present study. According to Tashakkori and Teddlie (1998, 2010), it is more efficient to answer research questions by mixed methods than by either a quantitative or a qualitative method alone. Besides, Creswell and Creswell (2017) claimed that the weaknesses/shortcomings of one research method could be offset by the strengths/advantages of another research method. For one thing, the weakness of a qualitative method means sometimes leaving out contextual sensitivities and focusing more on meanings and experiences (Silverman, 2010), which may be offset by one strength of a quantitative method: its findings are likely to be generalized to a whole population or a sub-population because it involves a larger sample (Carr, 1994). For another, the weaknesses of a quantitative method: leaving out the common meanings of social phenomenon (Denzin & Lincoln, 1998), failing to ascertain deeper underlying meanings and explanations (Rahman, 2016), and cannot account for how the social reality is shaped and maintained, or how people interpret their actions and others' actions (Blaikie, 2007), would be offset by the strengths of a qualitative method: producing the thick description of participants' feelings, opinions, and experiences and interpreting the meanings of their actions (Denzin, 1989), holistically understanding the human experience in specific settings (Denzin & Lincoln, 2002), and allowing the researchers to discover the participants' inner experiences and to figure out how meanings are shaped through and in culture (Corbin & Strauss, 2008).

The triangulation of data means that data is collected through multiple sources, such as interviews, observations, and document analysis, to ensure internal validity (Creswell & Creswell, 2017). According to Muller-Cajar and Mukundan (2007),

triangulation of one study means triangulating the study from the persectives of data, theories, investigators, methodologies and so on. For the current study, theoretical triangulation and methodological triangulation are applied.

Theoretical triangulation involves the design principles for MALL (Mobile-assisted Language Learning) as recommended by Stockwell and Hubbard (2013), dual coding theory (Paivio, 2007,1986, 1971), cognitive theory of multimedia learning (Mayer, 2005, 1997), a memory-based strategic framework for vocabulary learning (Ma, 2014a), providing the study with theoretical support.

Methodological triangulation involves collecting data with a mixed-method approach for the study. The benefits of applying triangulation can increase the validity of a study (Robson, 2002). Interpreting statistical data could be enhanced with the help from a qualitative description. In turn, a qualitative finding could be improved from quantitative evidences (Robson, 2002).

3.2 The Population and Samples

According to Frankfort-Nachmias and Nachmias (1996), the term "population" is identified as the entire set of relevant units of analysis or data. The population in a single study usually has the same or the similar features. Nevertheless, commonly, it is not practical to research into the whole population for a researcher in one study, for the population is typically too many to handle (Cohen et al., 2000). Therefore, for representing the population, a sample is often chosen for the study.

The population for this study was made up of 850 newcomers in 17 classes of arts students in Anshun University for the academic year 2019 in China. Next, two intact

classes with 114 non-English major first-year students out of 850 counterparts were chosen as samples based on convenience and availability for the present study. According to Mackey and Gass (2005), intact classes are employed for convenience. Creswell (2009, p.155) stated that "in many experiments, only a convenient sample is possible because the investigator must use naturally formed groups, such as a classroom, an organization or a family unit." Thus, applying intact classes is not only more authentic for students but also more reliable and convenient for the researcher to study.

The demographic information of the two classes, including the number, period of learning English, age, gender, and English proficiency, is shown in Table 3.1 below.

Table 3.1 The demographic information for the two classes in the study

	Average Age	**Gender**	**Length of Learning English**	**English Proficiency (150 full points)**	**T-value**	**Sig.**
Secretary class (N=56)	19	Male=26 Female=30	10-11 years	$\bar{X}$=94.27/150	.092	.927
Chinese language class (N=58)	18	Male=25 Female=33	10-12 years	$\bar{X}$=94.52/150		

Table 3.1 demonstrates that both classes have similar features in number, age, the proportion of males/females, and period of English learning. Furthermore, the mean of English proficiency from two classes was at a similarly low level, as the mean for the Secretary class was 94.27 points and that for the Chinese language class 94. 52 points by English test of NCEE (National College Entrance Exam) with 150 full points. This indicated that neither class was proficient in English. Their English proficiency was obtained from the English scores of NCEE in China, which is held yearly for screening

out students for universities all over the country, being well known for having high reliability and validity. Furthermore, an independent-samples t-test illustrated few differences in English proficiency between the two classes (P=0.927>0.05). This signifies that the two classes had almost the same levels of English proficiency before the experiment and that they were suitable for the experiment. Therefore, the Secretary class was randomly assigned as the experiment group and the Chinese language class as the control group.

3.3 Research Instruments

The instruments employed in the present study were the following: the target words, the mobile app, the size of the vocabulary test, the knowledge scale of the vocabulary, a questionnaire, semi-structured interviews, and diaries.

3.3.1 The Target Words

Based on the low pass rate in CET4 which ranges from 4.11% to 6.82% for the years 2015-2018 at Anshun university, improving their vocabulary is a must for university students because they all have to take the nationally recognized CET4 and passing CET4 is a prerequisite for a bachelor's degree of China (Zhang et al., 2011).

Also, based on the eight weeks' schedule of the freshmen in the academic year 2019, eighty words were picked out as target ones from CET4 vocabulary in terms of frequency. To decide on 80 target words, a corpus containing CET4 test papers (2014-2018) was compiled by the researcher. Then, an online software Word Frequency Counter was applied to count the frequency of words appearing in the corpus. Next, the top 80 high-frequency CET4 words were listed (Appendix A) for students to learn after

the researcher checking three CET4 vocabulary books (Liu, 2017; Ma, 2009; Yu, 2008).

Moreover, the 80 words were divided into eight packages randomly with ten words per package to be covered in eight weeks with one package per week. The reasons for choosing ten words per package for students to learn each time were as follows. According to Miyake and Shah (1999), working memory is responsible for holding information temporarily with a limited capacity. A quantification of the working memory capacity limit is the "magical number seven" put forward by Miller (1956). According to Miller (1956), the information-processing capacity of young adults is around 5 to 9 elements or "chunks" (seven plus/minus two), regardless of words, letters, digits, or other units. This claim has been approved and shared in various studies (Baddeley, 1992; Miller & Cohen, 2001; Neisser, 2014). Therefore, in order not to surpass the capacity of students' working memory, ten words were selected for each package for them to learn every time.

Furthermore, every target word was provided with a phonetic symbol, its part of speech, a Chinese definition, an example in a sentence, a picture, an audio file, and exercises. The Chinese definitions, parts of speech, and phonetic symbols were extracted from the Oxford Advanced Learners' English-Chinese Dictionary (2014), and the sentences, as well as the exercises, were from the three CET4 vocabulary books mentioned above. Next, the pictures and audio files were extracted from one search engine, Baidu, which is the most popular and dominant one of searching engines in China. Finally, all the materials concerning the target words were added to the mobile app, and then the Learning section as well as the Retrieval section of the app were set up. In order to clearly illustrate the descriptions above, sample screenshots in the mobile

app are shown in see 3.3.2, and the sample wordlist with the same ten words is displayed in Appendix D.

3.3.2 The Mobile App

The mobile app was designed with the assistance of an associate professor holding a Master of Science degree with fifteen years' teaching experiences. An introduction to the interface of the mobile app and two main sections (Learning sections and Retrieval sections of CET4 words) were designed step by step with the illustration of the word 'involve' on the app.

Step 1: the homepage of the mobile app appears after students log in with their ID number, as shown in Figure 3.1 below. The time allocated to each time learning is around 15 minutes for students, which refers to the pilot study.

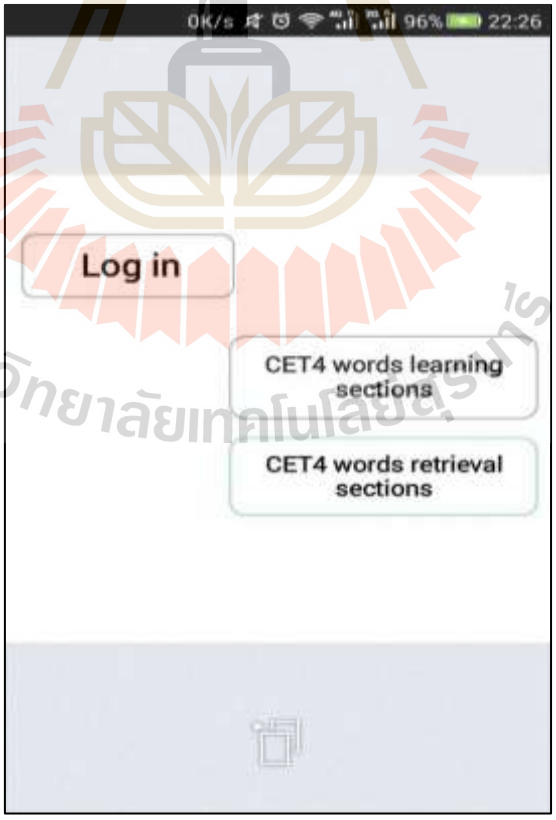


Figure 3.1 The interface of the mobile app homepage

Step 2: the interface of the Learning sections, including eight separate sections, pops out after clicking in, as illustrated in Figure 3.2 below. According to the 8-week schedule for the students, they click onto the appropriate Learning section in order.

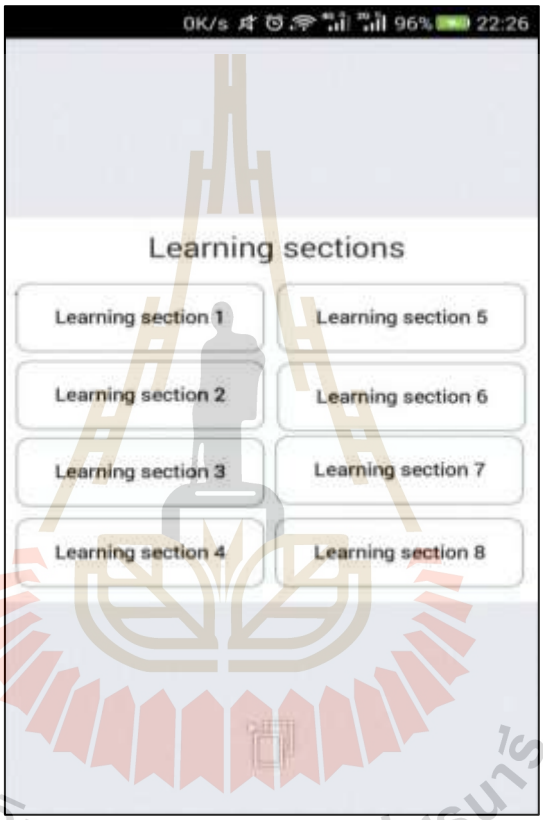


Figure 3.2 Screenshot of Learning sections interface

Step 3: In the first week, the interface of Learning section 1 shows up with ten words one by one after students' click onto Learning section 1, which is illustrated by Figure 3.3 with the first word 'involve.'

Figure 3.3 Screenshot of the word 'involve' in Learning section 1

Step 4: the interface of the Retrieval sections appears after the students finish Learning section 1 and click onto the Retrieval sections on the homepage, as shown in Figure 3.4.

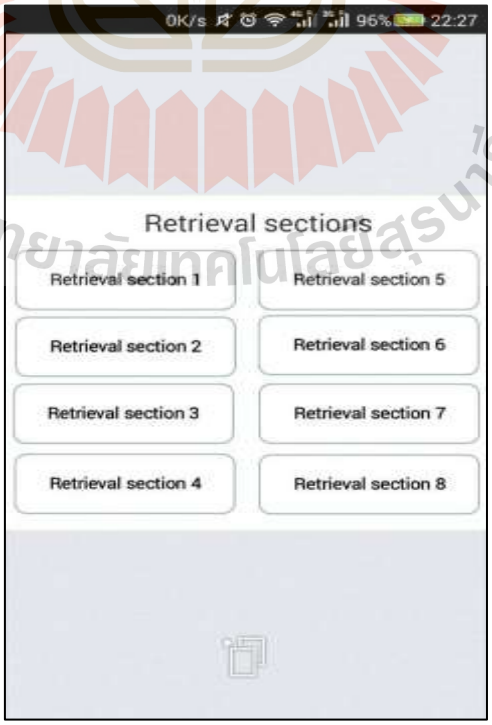


Figure 3.4 Screenshot of Retrieval sections

Step 5: The page of Retrieval section 1 containing three types of exercises appears after students click onto Retrieval section 1. There are three types of exercises and students ‘select the right meaning for given word’, ‘select the right word for given meaning’, and ‘spell the right word on given meaning’, respectively. Figure 3.5 below demonstrates the descriptions above.

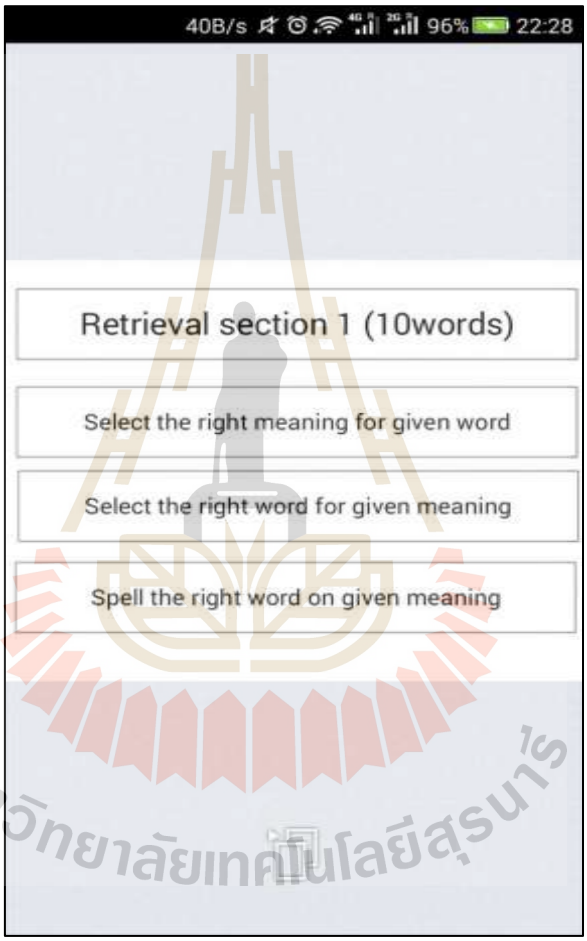


Figure 3.5 Screenshot of Retrieval section 1

Step 6: the page of ‘select the right meaning for given word’ appears after clicking onto the first column, as illustrated by Figure 3.6 with the first word ‘involve’.

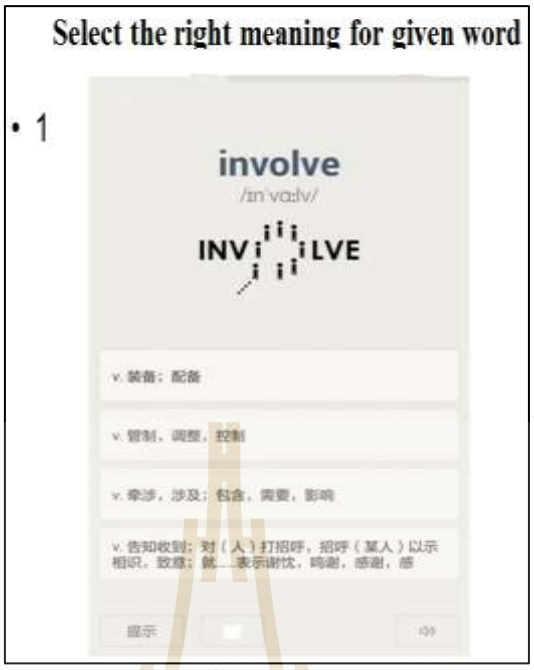


Figure 3.6 Screenshot of the word 'involve' in the first column

Step 7: the page of 'select the right word for given meaning' shows up after students finish the first type of exercise and click onto the second column, as shown in Figure 3.7 with the word 'involve'.

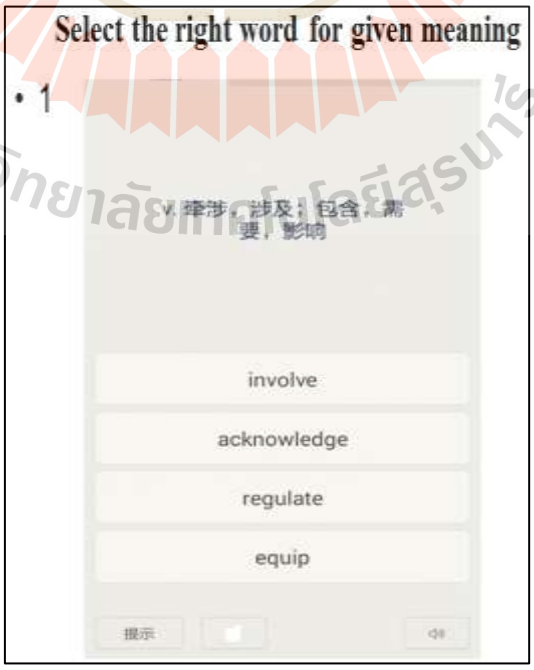


Figure 3.7 Screenshot of the word 'involve' in the second column

Step 8: the page ‘spell the right word on given meaning’ appears after students finish the second type of exercise and click onto the third column, as demonstrated by Figure 3.8 with the word ‘involve’.

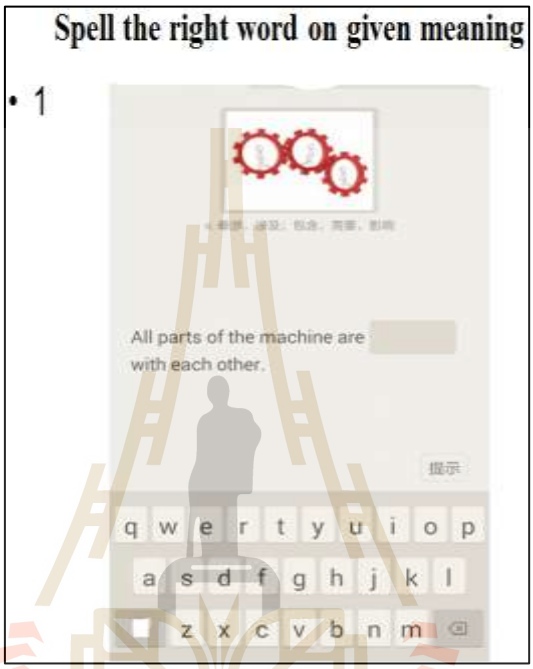


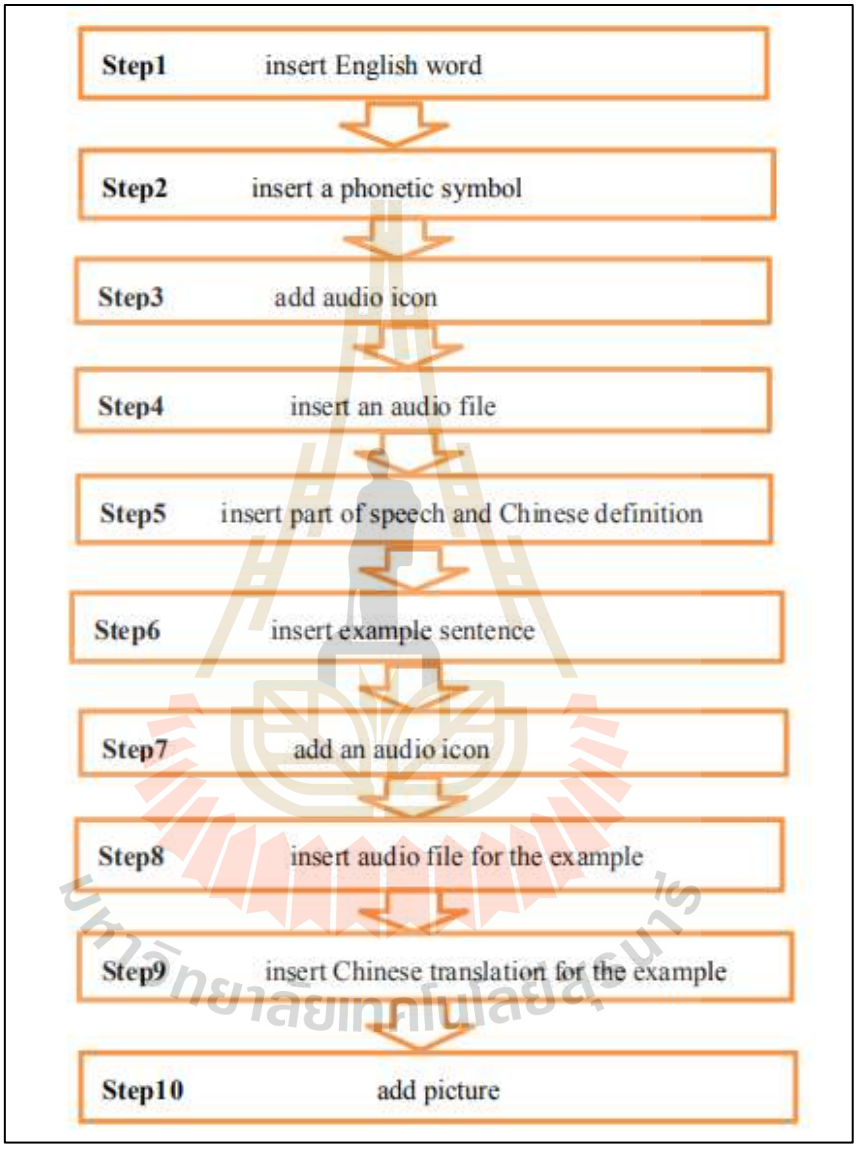
Figure 3.8 Screenshot of the word ‘involve’ in the third column

Step 9: the app automatically logs out each time when students finish the third type of exercise ‘spell the right word on given meaning’.

Developing the mobile app’s contents With respect to the programme and steps for developing the contents of the app, an introduction is given by the researcher, who consulted the computer engineer of the app. Firstly, the Android operating system takes 52% of about two million apps worldwide (Joorabchi et al., 2013), and 98% of the participants in the present study use smartphones with the Android operating system. Therefore, the Android operating system was used for developing the contents of the

app.

Then, steps to develop the contents for both the learning and retrieval sections are demonstrated by Flowcharts and Figures. See a sample word below.



Flowchart 1. Steps for designing Learning sections of one word in the app

Based on Flowchart 1 above and Figure 3.9 with the second word 'discharge' in Learning section 1 below, more explicit introductions were given. Firstly, the word followed by a phonetic symbol, by its part of speech as well as a simple Chinese

definition was presented with pictures and audio files at the same time. The reason why a simple Chinese definition is provided next to the word is because this is the most effective method for vocabulary learning (Ellis, 1995), and it helps learners learn a word more quickly if the meaning of the word is conveyed by a first language translation (Nation, 1982). In the present study, a simple Chinese definition refers to the primary meanings of the word extracted from the Oxford Advanced Learners' English-Chinese Dictionary (2014). Later, the example sentence with a Chinese translation is provided to help the students obtain the word meaning in context more easily (Groot, 2000).

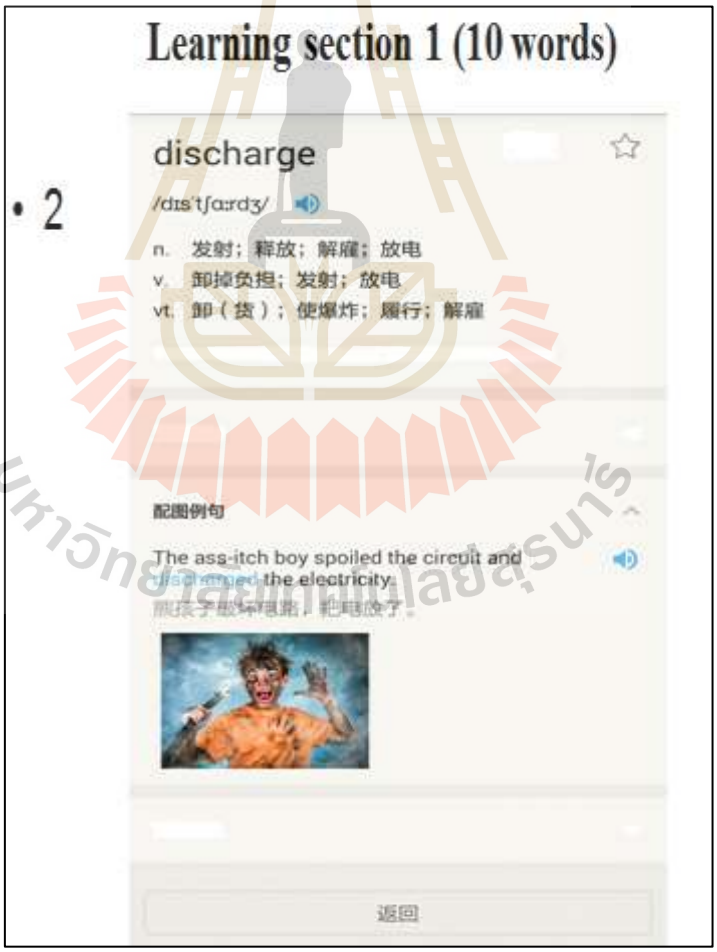
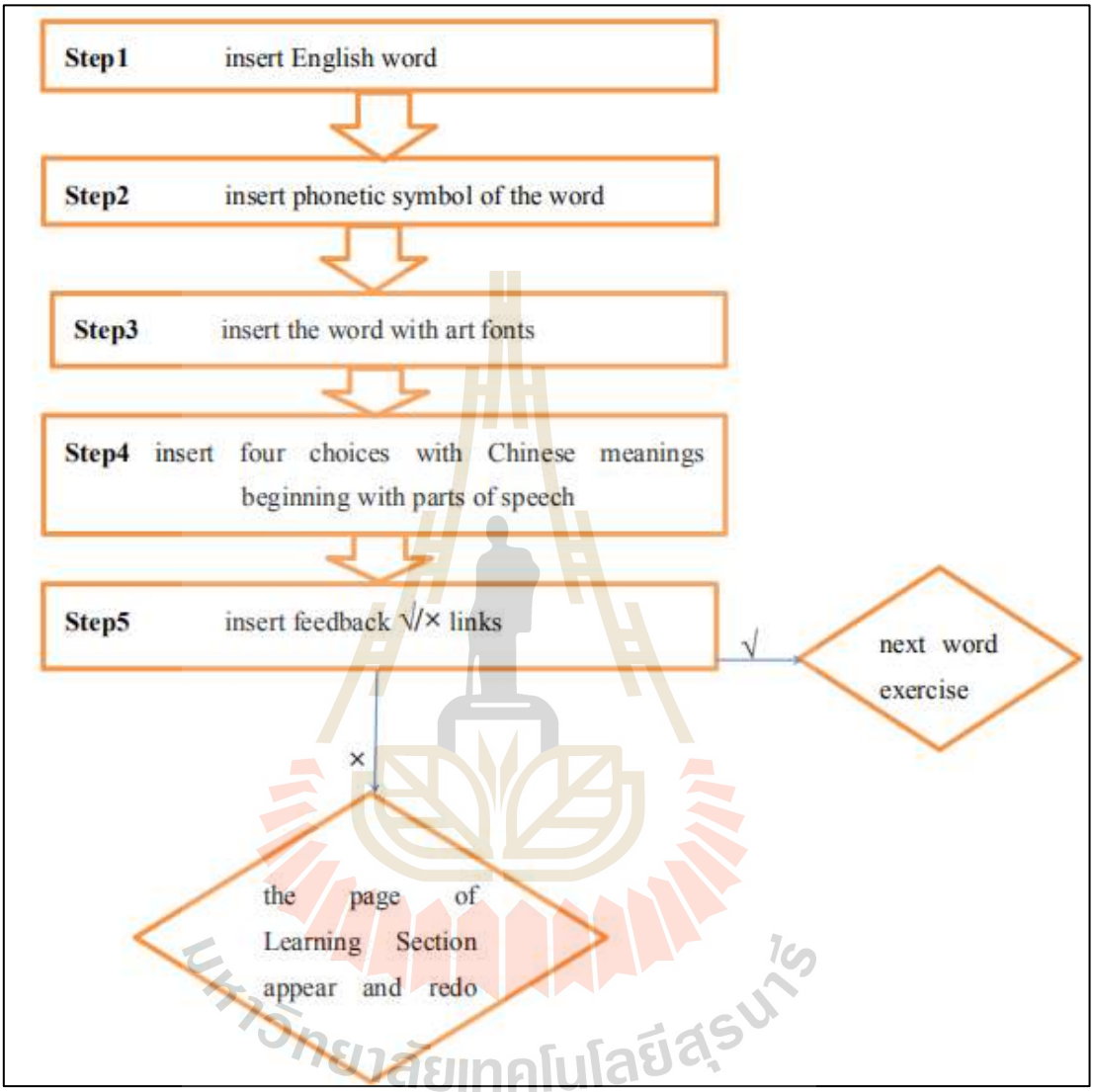


Figure 3.9 Screenshot of 'discharge' in Learning section 1 of the App

As mentioned above, in the Retrieval sections of the app, there are three types

of exercises: two multiple-choice exercises and one spelling exercise for each word. The steps for designing each exercise are presented with flowcharts below.



Flowchart 2 Steps for designing the first multiple-choice exercise in the App

In terms of Flowchart 2 above and Figure 3.10 below, the steps for designing the first multiple-choice exercise are presented. For the first multiple-choice exercise, students need to choose the corresponding Chinese meaning from four choices based on a given English word. When they select the right choice, they see a '√' feedback, and then the page will jump to another word exercise. When they select the wrong

choice, they see a '×' feedback, and the Learning section of the word appears. After the word is learned again, a link 'return' brings them back to the interface of the previous exercise.

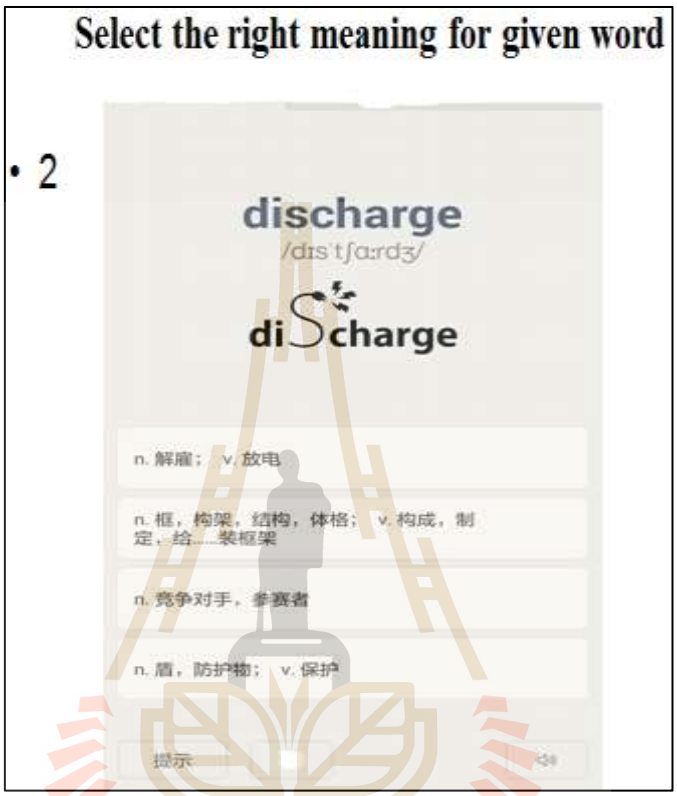
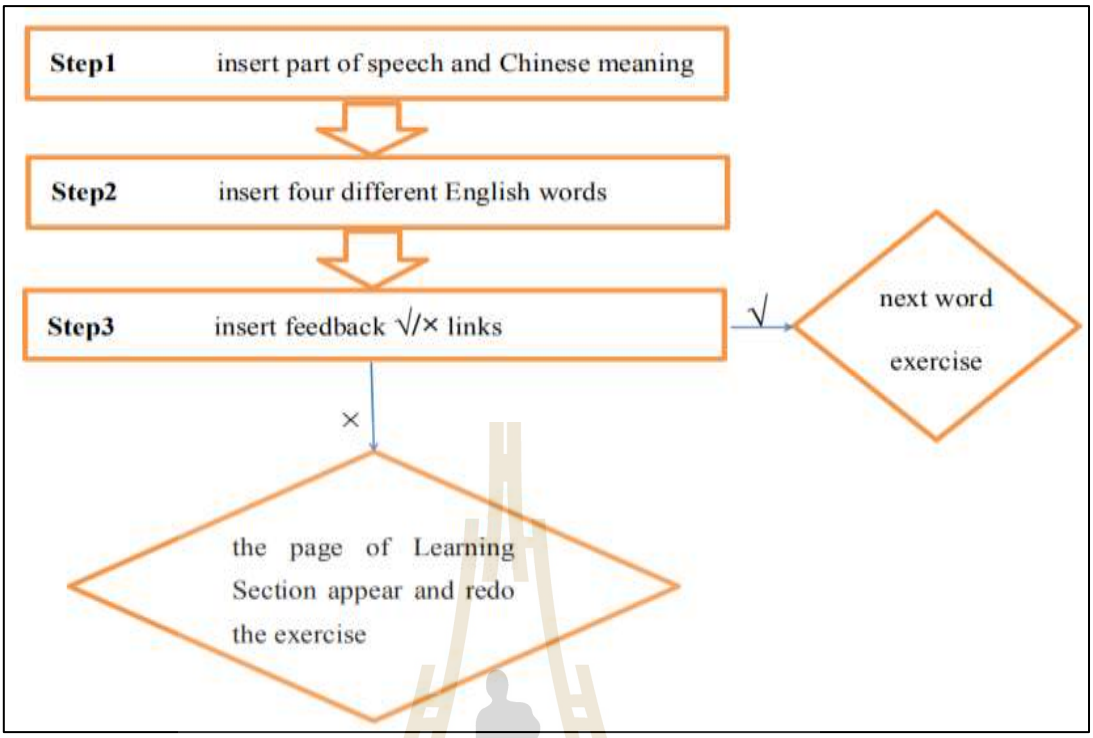


Figure 3.10 Screenshot of 'discharge' in the first multiple-choice exercise

As shown in Flowchart 3 and Figure 3.11 below, in the second multiple-choice exercise, students choose the corresponding English word from four words based on the given Chinese meaning. When they select the right word, the '√' feedback is seen, and then the page jumps to another word exercise. When they select the wrong word, the '×' feedback appears, and the Learning Section of the word pops up. As in the first type of exercise, a link 'return' in the Learning section helps students return to the page of the previous exercise.



Flowchart 3 Steps for designing the second multiple choice exercise in the app

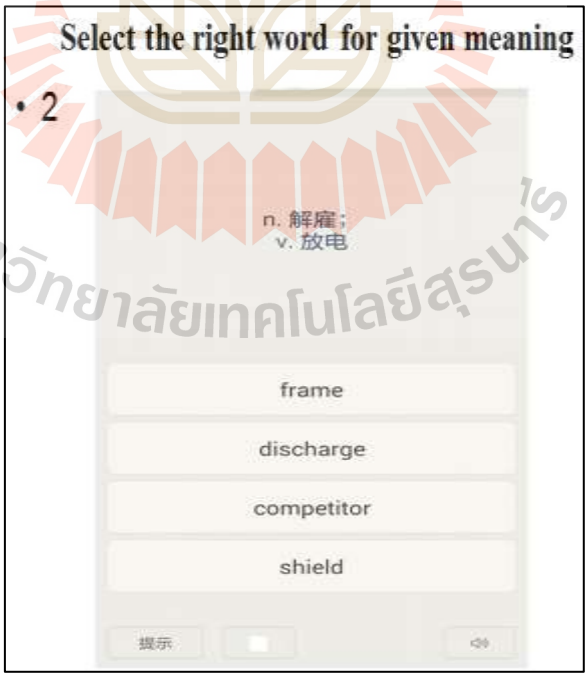
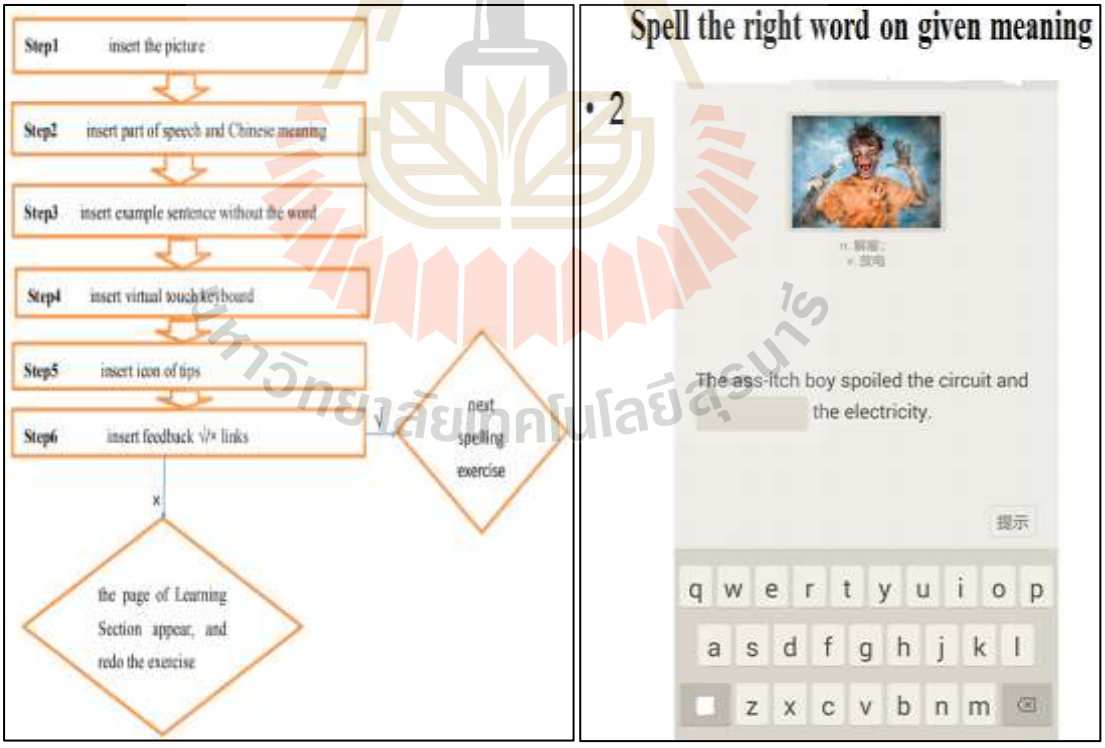


Figure 3.11 Screenshot of 'discharge' in the second multiple choice exercise

In respect to the third type of exercise, students spell the missing word in a sentence based on the given information. The steps for developing this type of exercise can be seen clearly in Flowchart 4, combined with Figure 3.12 below. Firstly, if students cannot recall the spelling of the word, they select the tips icon to relearn the word. After relearning, they select the link 'return' to go back to the page of the spelling exercise. Next, if students spell the word correctly, the '√' feedback pops up, and the page of another word spelling exercise appears. If the spelling is incorrect, the '×' feedback pops up, and then the page for the Learning section appears for students who want to check or relearn the word. As mentioned for the two types of exercise above, the link 'return' brings them back to the interface for the spelling exercise.



Flowchart 4 Steps for designing spelling exercise Figure 3.12 'Discharge' in spelling exercise

3.3.3 Vocabulary Size Test

Vocabulary Size Test (VST) (Nation & Beglar, 2007) was selected as a measurement for both groups before the treatment. The reasons for choosing VST were as follows. Firstly, VST was constructed by Nation and Beglar (2007) as a proficiency measurement of total vocabulary size for ESL/EFL learners. This is suitable for the present study, which examines if there is a difference of students' vocabulary size between 2 groups before the treatment.

Secondly, VST is a reliable instrument with a high reliability to measure vocabulary size. For validating VST, a Rasch-based test was done by Beglar (2010), and revealed 3 features summarized by Nguyen and Nation (2011, p.89): "1. It can be used with learners with a vast range of proficiency levels; 2. It measures a single factor (probably written receptive vocabulary knowledge), and other factors play a minor role in performance on the test; 3. It performs consistently and reliably, even though circumstances change. These changes include comparing the performance of male subjects with female subjects, comparing the 70-item version of the test with the 140-item version, and comparing learners of various proficiency levels". Finally, it was found that the reliability was 0.96.

VST contains 140 items with ten items representing each of fourteen 1,000-word levels from the British National Corpus. That is to say, his/her vocabulary size is likely to reach the 14,000-word level if he/she gets 140 full points. And its format is equipped with multiple choices, which is demonstrated in Figure 3.13 with an excerpt from VST (Appendix E).

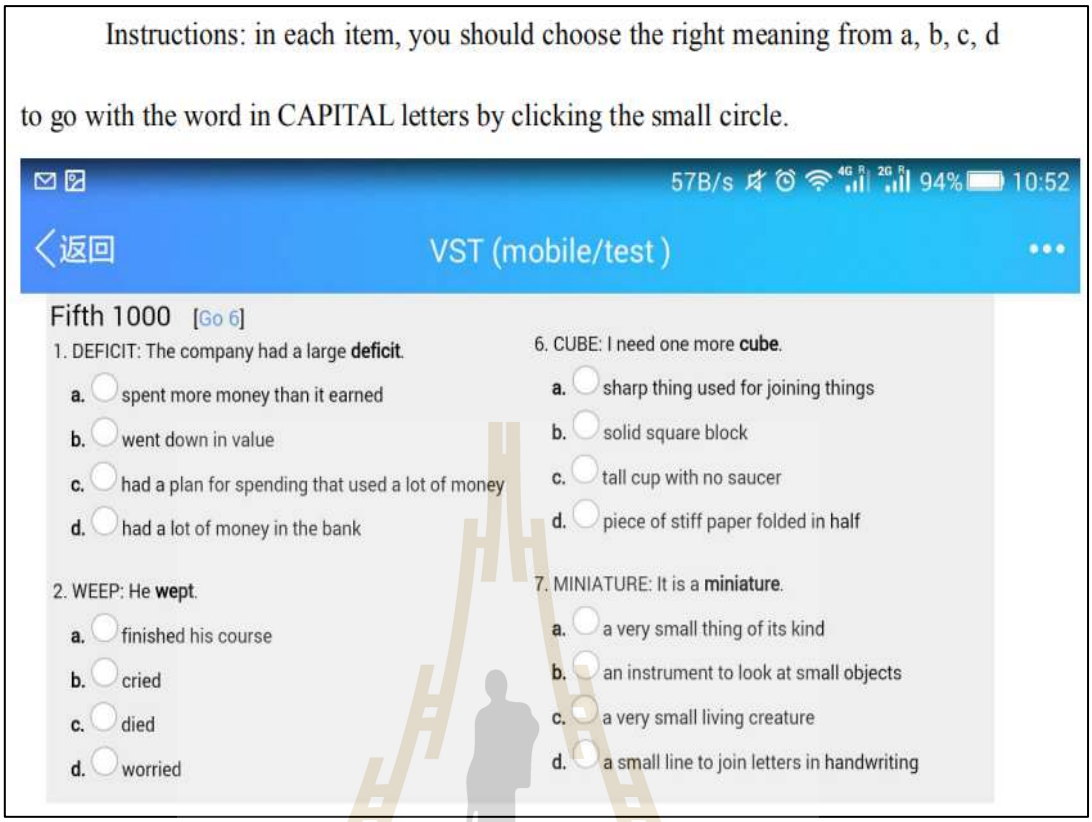


Figure 3.13 Snapshot of 5,000-word level in VST (Nation & Beglar, 2007)

Each item stands for a 100-word family and ten items represent every 1,000-word frequency level. Therefore, his/her vocabulary size can be deduced in the test by using the formula below.

Vocabulary size = Total scores × 100

3.3.4 Vocabulary Knowledge Scale

Vocabulary Knowledge Scale (VKS) was selected as the instrument for measuring vocabulary learning and retention of the study (Paribakht & Wesche, 1993). The reasons for selecting VKS were as follows. Firstly, it measured a broad range of knowledge types: noticing word forms, knowing the link between the word's form with

meaning, and using the word to make sentences in different contexts, which matched well with the stages and exercises of the words' learning via the app in the present study.

Secondly, the reliability of VKS was found to be high (0.89) by Wesche and Paribakht (1996), and it has also proven to be useful in measuring vocabulary learning and retention (Paribakht, 2005; Wesche & Paribakht, 2009). So the Vocabulary Knowledge Scale (Appendix F) is employed in the present study.

Paribakht and Wesche's (1997) VKS uses a five-point elicitation scale that comprises five items. It is demonstrated in Figure 3.14 below.

Instructions: choose the most suitable one (I-V) going with the bold word to fill in the bracket, and do as told if you choose one from III to V.

I. I don't remember having seen the word before.

II. I have seen this word before, but I don't know what it means.

III. I have seen this word before, and I think it means _____. (synonym or translation)

IV. I know this word. It means _____. (synonym or translation)

V. I can use this word in a sentence: _____. (Write a sentence.) (If you do this section, please also do Section IV.)

One example is shown how to do it.

E.G. **drive**, (V) I can drive the car. 驾驶

Figure 3.14 Snapshot of VKS with instructions (Paribakht & Wesche, 1997)

These categories are coded following the VKS Scoring Scale, in which possible points range from 1 to 5. As shown in Figure 3.15 below, the arrows mean that the selection of category I results in 1 point and the selection of category II in 2 points.

For categories III-V, various points can be awarded based on the quality of the answers provided. The full points for the VKS are 400 points.

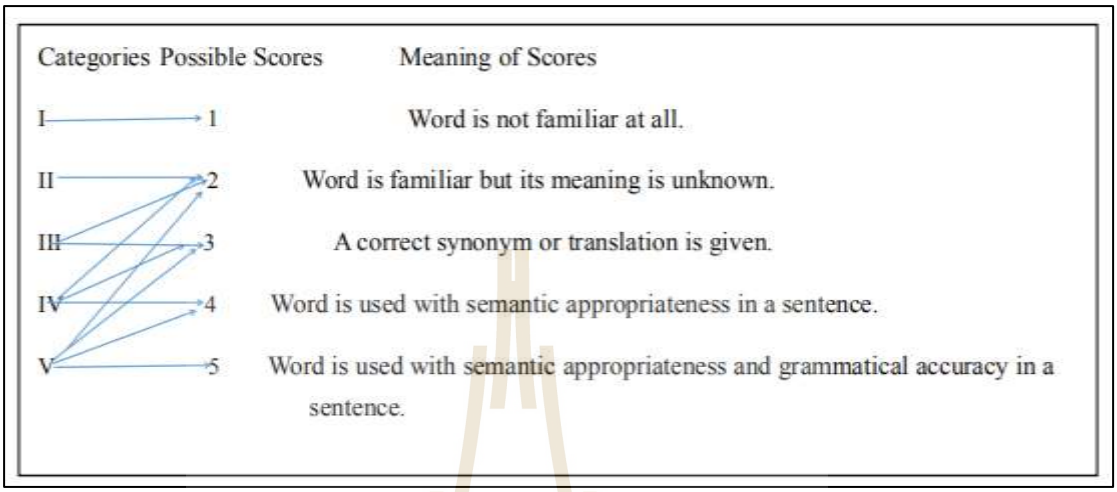


Figure 3.15 VKS scoring scale (Paribakht & Wesche, 1997, p.181).

For the study, the Target Words Knowledge Scale (Appendix F) was adapted from VKS (Paribakht & Wesche, 1997) and its reliability was tested. Moreover, the reliability was obtained by using reliability statistics with SPSS (18.0 version), as shown in Table 3.2 below.

Table 3.2 Reliability Statistics of Target Words' Knowledge Scale

Cronbach's Alpha	Number of Items
.89	80

As demonstrated in Table 3.2 above, Cronbach's Alpha of the words' knowledge scale is .89 ($\alpha = 0.89$). The knowledge scale can be accepted as reliable in the study, since a good reliability of a scale can be found, if Alpha is higher or equal to 0.7 (Deniz & Alsaffar, 2013).

3.3.5 The Questionnaire on Students' Perceptions

According to the researchers (Gass & Selinker, 2008; Krashen, 1981, 1982), within second language acquisition, an affective filter would indicate a learner's attitudes or perceptions of learning and suggest his/her level of language learning. So for probing into the subjects' perceptions of the current app, a questionnaire was administered in the study.

As for the construction of the questionnaire, items (2,5,6, and 8) were adapted from Chang et al. (2012), and items (3,7,11, and 13) from Wang (2015). The remainder of the questionnaire items were developed by the researcher.

The questionnaire consists of 2 parts: 1) students' background information; 2) students' perceptions of vocabulary learning via the app. The first part includes age, gender, period of learning English, English scores in NCEE, and experiences of English learning through a smartphone. Such data is necessary to provide the participants' demographic information. The second part includes 16 items to elicit students' perceptions of vocabulary learning via the app with a five-point Likert scale (5: strongly agree; 4: agree; 3: not sure; 2: disagree; 1: strongly disagree).

To examine the questionnaire content validity, the index of item-objective congruence (IOC) for checking content validity of developing items from Rovinelli and Hambleton (1977) was applied. Firstly, the IOC and IOC index can be calculated by the formula in Figure 3.16 below.

IOC=ΣR/ N

ΣR: the total score from experts

N: the number of experts

IOC index: IOC/the number of items

Figure 3.16 The formula for IOC and IOC index

Then, three English teachers rated each item to see whether it was congruent with the objective (congruent = 1, uncertain = 0, incongruent = 1). The background information of the three teachers is shown in Table 3.3 below.

Table 3.3 Background information of the three English teachers

	Age	Gender	Title	Years of English teaching
TA	44	female	Associate professor	15
TB	41	female	Associate professor	17
TC	52	male	Associate professor	30

The records of IOC for checking the items of the draft questionnaire are shown (see Appendix G), and its content validity was calculated as 0.875. According to Rovinelli and Hambleton (1977), an acceptable value for content validity should be higher or equal to 0.5. The IOC index (0.875) of the study, which meant that most of the items in the draft questionnaire were acceptable. The result of the IOC check revealed that four items (items 2, 5, 8, 13) in the draft questionnaire needed to be revised. After

revision, the present questionnaire in an English version (Appendix H) was made.

For testing the questionnaire reliability, it was trialed in one of the first-year non-English major classes with 55 students. The categories of "Analyze", "Scale," and "Reliability Analysis" were used in SPSS 18.0 and Cronbach's Alpha value is shown in Table 3.4 below.

Table 3.4 Reliability statistics of the questionnaire

Cronbach's Alpha	Number of Items
.913	16

According to Cronbach and Shevelson (2004), the coefficient of Cronbach's Alpha ranges from 0 to 1 by value. The larger the value is, the more reliable the questionnaire is. Besides, according to Deniz and Alsaffar (2013), good reliability of a questionnaire can be confirmed, if Alpha is higher than or equal to 0.7 ($\alpha \geq 0.7$). Therefore, it is reasonable to regard the questionnaire of the study as reliable because its Cronbach's Alpha is .913 ($\alpha = 0.913$).

3.3.6 Interview

An interview was selected as one way of data collection of students' perceptions for the study. According to Holstein and Gubrium (2004), an interview is a helpful instrument to generate information of personal perspectives and experiences for studies. Also, according to Creswell (2009, p.175), "as a qualitative research instrument, an interview enables an understanding of the meaning that the participants hold about the problem, not the meaning that the researchers bring to the research or writers express in the literature."

Furthermore, Fontana and Frey (2005) claimed that interviews would contain three types: unstructured interviews, semi-structured interviews, and structured interviews based on the degree of structuring. An unstructured interview is an interview without predetermined questions or answers (Minichiello et al., 1990; Punch, 1998). A semi-structured interview is in the middle between an unstructured interview and a structured interview. A structured interview is one where the interviewer asks each interviewee the same questions in the same order to collect consistent and comparable data (Patton, 2002). In the study, a semi-structured interview was decided, and the reasons for choosing it are listed as follows.

Firstly, according to Bernard (1988), in a semi-structured interview, the interviewer not only controls the process of getting information from interviewees, but also follows newly arising leads. Secondly, based on Denzin and Lincoln (1994), in practice, every interviewee is different, and the interviewer must be flexible enough to make appropriate adjustments for unanticipated developments. The semi-structured interview has the potential of flexibility to meet the interviewer's demands. Therefore, the way of semi-structured interview was decided for the study to collect data that could not be wholly or directly observed, such as beliefs, feelings, and perceptions, that the questionnaire would not necessarily cover.

With regard to what questions should be asked in the semi-structured interview, eleven questions were from the researcher referring to the questionnaire of students' perceptions to find in-depth answers to the third research question. Then, item-objective congruence (IOC) (Rovinelli & Hambleton, 1977) was applied for checking if interview questions could evaluate what they were supposed to assess.

A list of 11 interview questions and an evaluation form were delivered to

three experienced English teachers who rated the items of the questionnaire in section 3.3.5 above. The IOC and IOC index of three experts rating each question with the formula in Figure 3.17 below are shown in detail (Appendix I).

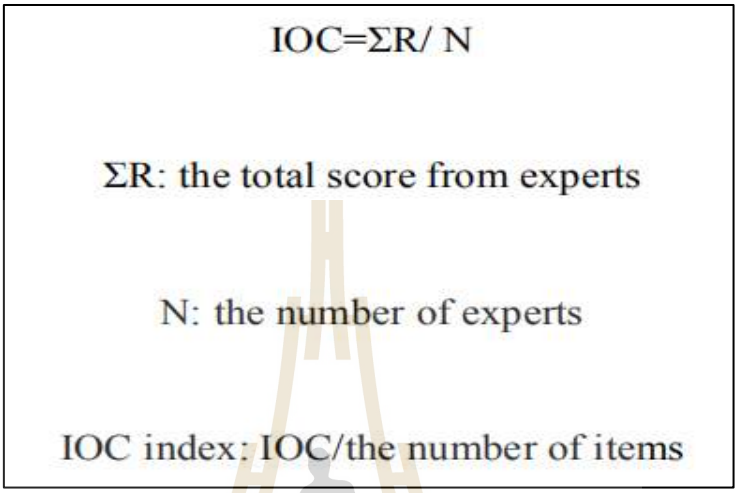


Figure 3.17 The formula for IOC and IOC index

The IOC index was calculated as 0.88 (See Appendix I). According to Rovinelli and Hambleton (1977), an acceptable value for content validity should be higher or equal to 0.5 (validity ≥ 0.5). Thus, most questions in the interview were valid and relevant with aims of the study. As a result, all interview questions were set (Appendix J-English Version) after questions 8 and 10 were revised. In order to avoid any misunderstandings of the interview questions, the interviews were conducted in Chinese (Appendix J-Chinese Version).

3.3.7 Diary

Students from two groups were required for keeping diaries about recording the length of time they learned and to provide feedback each week. Both of the groups reviewed each package of ten words based on 9 hours', 1 day's, 2 days' and 6 days' intervals from the first time they studied each week, as proposed in section 2.3 of

Chapter two. The format of the diary is shown in Table 3.5 below. In addition to recording the vocabulary learning each time, students were free to write comments, reflections, or anything relevant to their vocabulary study.

Table 3.5 The format of the diary for the experiment and the control group

Name:	**Student ID:**			**Major:**	
5 times/week ( )	First time learning on Monday	Second time	Third time	Fourth time	Fifth time
10 words/time	suitable time for learning words	9 hours' interval from 1st time	1 day's interval from 1st time	2 days' Interval from 1st time	6 days' Interval from 1st time
Starting to finishing time					
My feelings towards learning and reviewing words on week ( )					

3.4 Procedure of the Experiment

In Week 1, the purposes of the study were introduced briefly to the participants of the two groups in the classroom. At the same week 1, the students from the experimental group received a consent form (Appendix B) and signed it voluntarily. Also, the students from the control group signed a similar consent form (Appendix C). Then, the students from the two groups took the Vocabulary Size Test and the Vocabulary Knowledge Scale Test as pretests in the classroom which the researcher monitored. Next, in the same week, an introduction to the mobile app, including the eight packages with 80 target words (see 3.3.2), was made to the experiment group and then installed into their mobile phones. But the list of the same eight packages was distributed to the control group on sheets of paper (Appendix D).

In Week 2, the students from both groups were required to learn one package for the first time every Monday and review it four times outside the classroom in one week

for eight successive weeks. In addition, the students were required to keep diaries on the length of time of their vocabulary learning each time and their feelings, and then to hand in the diaries once a week.

In Week 10, both groups took the Vocabulary Knowledge Scale Test as well as the pretest but in a different order which the researcher monitored. In the same week, the experiment group completed the questionnaire on their perceptions (Appendix H, Chinese version), and the selected 19 participants were interviewed by the researcher individually based on the interview questions (Appendix J, Chinese version).

In Week 14, both groups took the Vocabulary Knowledge Scale Test but in a different order as a delayed-posttest which the researcher monitored. According to Ebbinghaus (1885), after four weeks, the information kept in mind would stay for a long time without much loss and in a stable state, so the delayed- posttest was held four weeks after the posttest. Table 3.6 below illustrates the timetable of the procedure.

Table 3.6 Timetable for two groups in the experiment

Week	Control group	Experimental group
1	The researcher's introduction to the purpose of the research (10 minutes); Take Vocabulary Size Test (40 minutes), Vocabulary Knowledge Scale Test (45 minutes);	
	The researcher handed out the paper-based wordlists (25 minutes);	The researcher's introduction and students' installation of the mobile app (30 minutes);
2-9	Learn and review the respective wordlist by paper-based method outside the classroom by week; Write and hand in the respective week's diaries;	Learn and review the respective package of words via the app outside the classroom by week; Write and hand in the respective week's diaries;
10	Take Vocabulary Knowledge Scale Test (45 minutes);	Take Vocabulary Knowledge Scale Test (45 minutes), complete the questionnaire of perceptions (20 minutes); 19 interviewees take the semi-structured interviews, with about 10 minutes for every interviewee.
11-13	Attend classes as usual without learning target words or reviewing;	
14	Take Vocabulary Knowledge Scale Test (45 minutes);	

3.5 Data Collection

In order to collect the data, the Vocabulary Size Test, Vocabulary Knowledge Scale, the questionnaire, the semi-structured interview, and diaries were introduced.

3.5.1 Vocabulary Size Test

For examining if a difference on vocabulary size can be detected between 2 groups before the experiment, they were pre-tested with the Vocabulary Size Test (Nation & Beglar, 2007). So at the first week in the first semester of 2019 academic year, both groups took a vocabulary size test in the classroom without any means of reference which the researcher monitored. It took the students 40 minutes to complete the Vocabulary Size Test. The students were only allowed to leave the classroom after they handed in the test sheet. The recovery rate of the Vocabulary Size Test sheet was 100%, which meant the researcher handed out a fixed number of test sheets for students to finish and later all test sheets were collected back.

3.5.2 Vocabulary Knowledge Scale

To find out how much the two groups knew the target words before the treatment, and to measure their permormances on learning vocabulary and on retention, the Vocabulary Knowledge Scale Test, which was adapted from the VKS (Paribakht & Wesche, 1993,1997) was employed in 3 tests: pretest, post-test, and delayed-posttest.

Firstly, in the first week, the VKS was handed out to both groups to finish within 45 minutes in a closed-book test which the teacher monitored. Secondly, in the tenth week after eight weeks' vocabulary learning, the two groups were assessed in a posttest by using the same Vocabulary Knowledge Scale as in the pretest but in a different order in the English classroom which an English teacher monitored. Finally,

the delayed-posttest was finished four weeks after the posttest. The VKS of the posttest was the same as that of the delayed-posttest but in a different order. All the tests were completed using paper and pencil, and the recovery rate of the VKS test sheets in the pretest, posttest, and delayed-posttest was 100%.

3.5.3 The Questionnaire on Perceptions

In the tenth week, after the students from the experiment group had finished the posttest, they filled out the questionnaires and returned the questionnaires to the researcher within 20 minutes in the classroom. After all questionnaires were collected back by the researcher, they were number coded.

3.5.4 The Semi-structured Interview

According to the criteria for selecting the number of interviewees from the Alberta Municipal Health and Safety Association (AMHSA, 2010), a representative amount of the interview sample was decided on (Appendix K). The criteria present the minimum number of interviewees relying on different amounts of participants, which would represent the sample size of interview (Shen & Suwanthep, 2011).

Based on the criteria above, the number of 19 out of 56 students in the experimental group would be a minimum amount and proper for the semi-structured interview. So, 19 interviewees were selected based on purposive sampling in terms of their responses to the questionnaire and diaries.

After the students from the experiment group finished the posttest and the questionnaire in the 10th week, the selected 19 interviewees were called into a classroom, and individual interviews were conducted in another classroom by the researcher. In the process of interviewing, the responses from the students were

recorded by a tape recorder. To make all interviewees understand interview questions and elaborate their thoughts clearly, their mother language: Chinese language was used. Notes were also taken in case the tape recorder failed to work.

3.5.5 The Diary

From the second week on, the students from the two groups handed in their diaries to the researcher on every Sunday evening for eight successive Sunday evenings. Then, the researcher would check the vocabulary learning diary of every student carefully and give some reminders if if anyone had not done the vocabulary learning or review as the schedule.

3.6 Data Analysis

For this section, the methods of how to analyze data are described. Table 3.7 below demonstrates the employed data analysis.

Table 3.7 Data analysis and its objective

Data from	Data analysis	Objectives
VST	Mean and S.D. analysis Paired-samples t-test Independent-samples t-test	To examine the difference in vocabulary size between 2 groups before the experiment
VKS	Mean and S.D. analysis Paired-samples t-test Independent-samples t-test	To identify students learning of words and retention
Questionnaire	Percentage analysis	
Semi-structured interview	Thematic analysis	To explore students' perceptions of the app by triangulation
Diaries	Thematic analysis	

3.6.1 Analyzing the Data of VST

Firstly, after the data of VST was collected, descriptive statistics were performed with SPSS (18.0 version) for gaining an overview about the data. Secondly, an independent-samples t-test was used to examine if a huge difference on the mean vocabulary size existed between the two groups, and whether they were qualified for the experiment.

3.6.2 Analyzing the Data of VKS

The data from VKS in the pretest

Firstly, the mean and standard deviation were applied to describe the VKS with the help of SPSS 18.0. Secondly, to see whether a significant difference existed in the knowledge of the target words between 2 groups, the mean of knowledge of the target words was analyzed by an independent-samples t-test.

The data from the VKS in the posttest

Firstly, the mean and standard deviation were employed to describe the VKS by SPSS 18.0. Next, a paired-samples t-test was applied to examine if any difference on mean of knowledge of the words existed between the pretest and posttest for each group. Then, an independent-samples t-test was used to examine if a difference existed between two groups on mean of knowledge of the words from the posttest. The data analyses were used to answer the first research question.

The data from VKS in the delayed post-test

At first, M and S.D. were for describing the students' knowledge of the words by SPSS 18.0. Then, a paired-samples t-test was performed to explore if a difference was exhibited between the delayed-posttest and the posttest on mean for each group. Next,

an independent-samples t-test was done for examining whether a difference on students' knowledge of the words was exhibited for delayed-posttest of 2 groups. The aim of data analyses was for answering the second research question.

3.6.3 Analyzing the Data of the Questionnaire

The data of the questionnaire was analyzed using descriptive statistics. To be precise, the percentages in the descriptive statistics of SPSS 18.0 were used for analyzing students' questionnaires and the percentage of each item was calculated. Because six students did not complete all the items of their questionnaires, the remaining fifty students' questionnaires were analyzed. The results of the questionnaires combined with those of the semi-structured interviews and the diaries were sufficient to answer the third research question.

3.6.4 Analyzing the Data of the Semi-structured Interviews

Firstly, the researcher transcribed the responses of the interviewees to produce a written version. Later, the transcripts were translated properly into English if they were expressed in Chinese. Thirdly, the translations and transcripts were read very carefully by the researcher and three English teachers with more than fifteen years' teaching experiences mentioned in section 3.3.5 in order to form the first impressions.

As Dörnyei (2007) argues, those impressions affect the way one researcher perceives and codes the data eventually. Reading the transcripts reflectively, the researcher sifts data line by line. This is the time when coding begins as the first step to categorize the raw data.

Fourthly, coding needs to be followed by key concepts so that these can develop into final themes step by step. Finally, the summarized themes out of

questionnaires and diaries revealed the in-depth reasons as part of answers to the third research question.

3.6.5 Analyzing the Data of the Diaries

Diaries can be a kind of qualitative data, for they record things subjectively (Walsh, 2003). As for the current study, students' dairies would offer the researcher much in-depth information concerning their feelings, opinions, feelings, reflections, and the unknown.

After students' diaries were all collected, they were number coded in ascending order of the students' IDs each week. Then, based on the "open coding"[3] technique proposed by Punch (1998) and the "axial coding" technique proposed by Strauss and Corbin (1998), the raw data was reduced by coding and synthesis to find the categories and themes. These categories and themes were used to verify the answers to the first and second questions, and then to further answer the third research question with the data from the questionnaire, as well as from the interviews.

3.7 Implications from Pilot Study and Adjustments for Main Study

It has been claimed that "a pilot study is a small-scale trial of the proposed procedures, materials, and methods, and sometimes also includes coding sheets and analytic choices" (Mackey & Gass, 2005, p.43). They also claim that a pilot study is useful for researchers to test the feasibility of the proposed research project and to fix

3 "Open coding" is the process of "breaking down, examining, comparing, conceptualizing, and categorizing data"; it is "the part of the analysis that pertains specifically to the naming and categorizing of phenomena through close examination of data" (Punch, 1998: 207-211). Whereas, "Axial coding" is "a set of the process whereby data are put back together in new ways after open coding paradigms involving conditions, context, interactional strategies and consequences" (Strauss & Corbin, 1998: 61-62).

the uncovered problems for the main study. Thus, the pilot study was did for examining the plausibility of the research project, and to explore if any adjustment was necessary before the main study.

A pilot study was done for 2 classes, with 116 Chinese EFL newcomers who were picked out by the researcher's availability and convenience at the first semester of 2018 academic year. The detailed report of the pilot study is attached (see Appendix J). Furthermore, the results of the pilot study proved that the current research project was plausible. Moreover, several implications from the pilot study were listed, and corresponding adjustments were made for the main study as follows.

Firstly, when students filled in the questionnaire, ten students did not understand "the clues of the images" in item 12: 'I can learn the words easier based on the clues of the images and example sentences in the app, and needed more explanations.' Moreover, eight students asked what 'the contexts of the example sentences' meant in item 15: 'the contexts of the example sentences help me learn how to use the words appropriately.' Later, "the clues of the images" was changed into "the pictures" in item 12, and "the contexts of the example sentences" was changed into "the example sentences" in item 15. These changes helped students understand more quickly and clearly. The revised questionnaire for the main study is shown in Appendix H.

Secondly, during the interviews, some interviewees just responded with "yes" and did not say anything else in answer to the interview questions (5, 6, 7, and 8), because all the questions began with "is it…?" Thus, to elicit more responses from the interviewees, the above questions were revised as open-ended questions, and adjusted accordingly. The revised list of interview questions is shown in Appendix H.

Finally, the students' diaries were added as another research instrument in the main study. Because the improved vocabulary learning and retention of the experimental group in the pilot study might have something to do with the greater number of times used for vocabulary learning via the mobile app than for the paper-based wordlist, to reduce the effects of the unequal times, the two groups were required to learn the target words five times within one week and to keep diaries on the length of time they spent each time. Another aim of adding diaries as an instrument was to triangulate the answers to the third research question with students' unseen writings, by combing the questionnaires and the interviews.

3.8 Summary

To sum up, this chapter describes the research methodology for the study in detail. At the beginning, the research design was explained. Then, the population and samples in the study were introduced. Later, the research instruments were presented respectively, which comprised the target words, the mobile app, the vocabulary size test, the vocabulary knowledge scale, the questionnaire, the semi-structured interview, and the students' diaries. Next, the procedure of the experiment was introduced, which was then followed by the data collection. Additionally, the processes of data analysis were described in order to answer the three research questions. Finally, some adjustments were done to the main study from the researcher's pilot study. In Chapter 4, the results of the data analyses and the discussion are presented.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the results and then makes discussions in reference to the research, theories relevant to the results of the present study. Firstly, the results of the Vocabulary Size Test for the two groups are presented. Then, the results of the pretest and posttest on the students' knowledge of the target words are illustrated to answer the first research question which is followed by a discussion. Next, the results of the delayed-posttest concerning knowledge of the target words are used to answer the second question, which is followed by a discussion. Later, the results of the questionnaires, the interviews, and the students' diaries from the experimental group are used to answer the third research question which is followed by a discussion. Additionally, the results of the students' diaries from the control group and the related discussion are presented. Finally, this chapter concludes with a summary.

4.1 Results of the Vocabulary Size Test

The Vocabulary Size Test (VST) was developed by Nation and Beglar (2007) as a proficiency measurement of total vocabulary size for EFL/ESL learners. VST is made up of 140 items (Appendix E), and has been proved as a reliable measurement with a reliability value of 0.96 (Beglar, 2010).

In order to examine whether there were significant differences on students' vocabulary levels between two groups and to assess whether they were suitable for the

experiment, descriptive statistics and an independent-samples t-test were employed. Then, Table 4.1 below illustrates what is found.

Table 4.1 An independent-samples t-test of vocabulary size from the two groups

Vocabulary Size Test				
Group	**$\bar{X}$**	**Standard Deviation (S.D.)**	**T-value**	**Sig. (2-tailed)**
EG (N=56)	1989.29	644.044	15.057	.293
CG (N=58)	2110.34	578.470		

EG: Experiment Group and CG: Control Group (Significant level p<.05)

As shown by Table 4.1, the mean of the vocabulary size from the experimental group is 1989.29 (S.D.=644.044), and the mean of the vocabulary size from the control group is 2110.34 (S.D.=578.470). However, no significant difference between the mean of EG and the mean of CG was detected (p=0.293) from an independent-samples t-test. Furthermore, in terms of the mean of the two groups, their average vocabulary size was around 2,000 words, which was far from the requirement of 4,500 words for CET4 in China. The results disclosed that two groups stayed at a similarly low level in terms of vocabulary size, indicating that both of them lacked sufficient vocabulary knowledge and needed to learn more vocabulary in order to pass the CET4. Therefore, the students from both groups were suitable for the experiment.

4.2 The Effects of Using the App on Students' Vocabulary Learning

This section provides the results for answering 1st question (RQ1): What are the effects of using the mobile app on EFL students' vocabulary learning achievement? To answer RQ1, descriptive statistics, a paired-samples t-test, and an independent-samples t-test of the Target Words Knowledge Scale Test were conducted.

4.2.1 Results of an Independent-samples T-test of the Pretests for 2 groups

The Target Words Knowledge Scale Test (Appendix F) was adapted from the Vocabulary Knowledge Scale (Paribakht & Wesche, 1997), and the Knowledge Scale Test proved to be reliable with a reliability of 0.89 based on Deniz and Alsaffar (2013).

From CET 4 vocabulary, the top 80 high-frequency words were chosen for 2 groups' learning. To examine whether the target words were suitable for them to learn, and whether there was a difference of knowledge of the target words between them, the Target Words Knowledge Scale Test was administered as a pretest for both groups.

Table 4.2 An independent-samples t-test of the pretests of the two groups

Test	Group		Full points (400)	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
Pretest	EG (56)	Highest score	172/400	145.88	28.258	39.316	.662
		Lowest score	95/400				
	CG (58)	Highest score	184/400	143.82	22.707		
		Lowest score	85/400				

EG: Experiment Group and CG: Control Group (Significant level $p<.05$); The total scores of the Target Words Knowledge Scale Test are 400 points.

According to Table 4.2, the mean score of the pretest from the experimental group was 145.88 (S.D. = 28.258), with their scores ranging from 95 to 172. The mean score of the pre-test from the control group was 143.82 (S.D. = 22.707), with their scores ranging from 85 to 184. This indicates that the target words were unknown to the students from either group, so they could be used for them to learn. Next, after an independent-samples t-test, no significant difference between the mean of EG and that of CG was identified ($p = 0.662$). It meant that 2 groups exhibited a similar level concerning their knowledge of the target words which suggested they were suitable for

the treatment.

4.2.2 Results of the Post-test and a Paired-samples T-test for EG

The post-test of target words was carried out after eight weeks' treatment. With descriptive statistics, the results of post-test for experimental group are shown in Table 4.3 below. Later, a paired-samples t-test was performed for experimental group to determine the difference between mean of pretest and that of post-test, as demonstrated by Table 4.4.

Table 4.3 Descriptive statistics of the post-test for EG

EG (N=56)		$\bar{X}$	S.D.
Highest score	365/400	328.16	44.978
Lowest score	309/400		

EG: Experiment Group; The total scores of the Target Words in the Knowledge Scale Test was 400 points.

Table 4.4 A paired-samples t-test of the pretest and the post-test for EG

Tests	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
Pretest	145.88	28.258	12.386	.000
Post-test	328.16	44.978		

EG: Experiment Group (Significant level p<.05); The total scores of the Target Words in the Knowledge Scale Test were 400 points

According to Table 4.3 above, mean of post-test from experimental group was 328.16 (S.D = 44.978), with scores ranging from 309 to 365. Furthermore, according to Table 4.4 above, mean of experimental group changed from 145.88 for the pretest to 328.16 for the post-test, an increase of 182.28 (125.2%). In addition, the result of the paired-samples t-test disclosed that a significant difference between mean of pretest and mean of post-test was detected ($p = 0.000<0.05$). It suggested that learning achievements of the target words were improved noticeably for those students who used

the app after an eight-week treatment.

4.2.3 Results of the Post-test and a Paired-samples T-test for CG

The results of post-test for control group after using descriptive statistics are given in Table 4.5 below. Next, a paired-samples t-test was performed for control group to determine the statistical difference between mean of post-test and that of pretest, as demonstrated in Table 4.6 below.

Table 4.5 Descriptive statistics of the post-test for CG

CG (N=58)		$\bar{X}$	S.D.
Highest score	281/400	242.20	34.550
Lowest score	196/400		

CG: Control Group. The total scores of Target Words in the Knowledge Scale Test were 400 points.

Table 4.6 A paired-samples t-test of the pretest and the post-test for CG

Tests	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
Pretest	143.82	22.707	11.203	.000
Post-test	242.20	34.550		

CG: Control Group (Significant level p<.05) ; The total scores of the Target Words in the Knowledge Scale Test were 400 points.

According to Table 4.5 above, mean of post-test for control group was 242.20 (S.D = 34.550), with their scores ranging from 196 to 281. As illustrated by Table 4.6 above, mean of control group changed from 143.82 on the pretest to 242.20 on the post-test, which is an increase of 98.38 (68.4%). By further analysis, the result of the paired-samples t-test showed that a significant difference between mean of pretest and mean of post-test was identified ($p = 0.000<0.05$). These results indicate that the students' learning achievements of the target words improved significantly for the students using the paper-based wordlist for eight weeks.

4.2.4 Results of an Independent-samples T-test of Post-tests for 2 Groups

An independent-samples t-test was performed to detect the statistical difference between 2 groups' mean of post-tests. Moreover, the results of the independent-samples t-test are presented in Table 4.7 below.

Table 4.7 An independent-samples t-test of the post-tests for the two groups

Test	Group	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
Post-test	EG (N=56)	328.16	44.978	40.472	.000
	CG (N=58)	242.20	34.550		

EG: Experiment Group and CG: Control Group (Significant level p<.05); The total scores of the Target Words in the Knowledge Scale Test were 400 points.

As displayed by Table 4.7 above, the mean score of the post-test for the experimental group (M = 328.16; S.D. = 44.78) is much higher than that of the control group (M=242.20; S.D.= 24.550). By further analysis with an independent-samples t-test, a statistically significant difference was detected ($p = 0.000 < 0.05$). This means that the students learned more words by using the app compared with those using the paper-based wordlist, indicating that the app was more effective in improving students' vocabulary learning.

4.3 Discussion about the Effects of the App on Vocabulary Learning

As mentioned above, those students with the mobile app learnt more words than their peers by the wordlist. Similarly, Wang and Shih (2015) showed that the students with a mobile app scored significantly higher in the vocabulary post-test than their counterparts, indicating that the app was effective in improving EFL vocabulary learning. As found by Poláková and Klímová (2019), the students using a mobile app

obtained higher scores than the students using traditional methods on vocabulary learning tests. According to Chen et al. (2019), the performance in vocabulary learning by EFL students using a mobile app was significantly better than that of their counterparts. Nevertheless, the results are different from those of Dehghan et al. (2017) who did not find any significant difference in vocabulary learning between the WhatsApp group and the textbook-based wordlist group. The reason for this might be that the students using WhatsApp were often distracted from vocabulary learning while chatting with friends or listening to music or something unrelated to the task online, since WhatsApp has a reputation as an entertaining communication app (Church & de Olivia, 2013). To look closely at findings from the study, however, the four reasons below may account for the experimental students' more significant performances.

Firstly, the merits of a multimedia environment in the app were displayed in helping the students with learning vocabulary. The combination of pictures and texts helped learners understand words easily and stimulated their motivation, because they gave the learners a role as a knowledge constructor, who could select and connect pieces of information from visual and verbal sources (Gonulal, 2019; Mayer, 1997). Also, Kim and Gilman (2008) found that a multimedia environment was likely to motivate students to concentrate on EFL vocabulary learning. Moreover, Matsuoka and Hirsh (2010) highlighted that a deep understanding of vocabulary due to the multimedia environment would facilitate a better transfer of vocabulary knowledge to authentic contexts and leave deep impressions on learners. They also argued that the multimedia environment can help L2 learners remember the words faster and it is superior to the learning of words in isolation. These results are consistent with the research (e.g. Al-Seghayer, 2016; Govindasamy et al., 2019; Mayer & Fiorella, 2014; Ramezanali, 2017;

Rusanganwa, 2015), which revealed that a multimedia presentation of words by text, sound, and pictures, could help learners learn the words faster and retain them longer.

Secondly, the immediate corrective feedback in the app assisted students to adjust their vocabulary learning, and then helped them store the correct meanings as well as the forms of the words in their minds. The researchers (Henderson, 2019; Soria et al., 2020; Sprenger, 2018) found that immediate corrective feedback helped considerably in developing students understanding of vocabulary, monitoring their vocabulary learning, and correcting any incorrect guess before they stored the right vocabulary knowledge in their long-term memory. According to Mollakhan et al. (2013), the corrective feedback was beneficial for Iranian EFL students to realize and revise errors when they were learning new vocabulary. Besides, it was identified that corrective feedback when offered promptly would increase learning, for it could help learners correct their mistakes and maintain right responses (Pashler et al., 2005; Roediger & Butler, 2011).

Thirdly, the students' more significant achievements in vocabulary learning may be due to their enjoyment of using a new app. According to Green (1993), there was a positive correlation between the enjoyment induced by something and good impacts on learning. As stated by Sandberg et al. (2011), using a mobile app brought much enjoyment and fun to the students, which motivated them to use the app in their spare time and benefited their EFL learning. Additionally, according to Hsu et al. (2017), the enjoyment of using mobile apps among senior high school EFL students could improve their relaxation levels and sustained their attention levels on vocabulary learning. Thus, the students exhibited substantial vocabulary learning achievements, regardless of gender. Therefore, it is reasonable to believe because of enjoyment, happiness, and fun,

that an app brings, students like the activity of learning vocabulary with the app, which, in turn, contributes to increasing achievements of the vocabulary test.

Lastly, the audios of words in the app helped students' with right pronunciations, which might result in better vocabulary learning. According to the researchers (Celce-Murcia, 2001; Laufer, 1998), the right pronunciation of a new word was quite significant for L2 vocabulary learning. As claimed by Min (2013), many EFL learners could not learn words very well, for their misspelled words were probably due to the words' being mispronounced. Besides, according to He et al. (2015), and Kaplan-Rakowski and Loranc-Paszylk (2019), EFL learners improved their pronunciation of words by listening to audio recording which facilitated the rate of delivering and retrieving words, for they could learn EFL words better from the similarities between the orthographic and the acoustic of the words, as disclosed by Hennings (2000) and McCarthy (1994). These findings are in agreement with those of the studies (Karousou & Nerantzaki, 2020; Trofimovich & Issacs, 2012), which revealed that the students with access to recordings and phonology were better at remembering and retrieving lexical items. Moreover, EFL university students generally reported that the opportunities to practice pronunciation via a mobile app was the one most motivating and beneficial features of learning vocabulary (Kohnke, 2020).

4.4 The Effects of Using the App on Students' Vocabulary Retention

This section presents the results for answering the second research question (RQ2): What are the effects of using the mobile app on EFL students' vocabulary retention? To answer RQ2, descriptive statistics, a paired-samples t-test, and an independent-samples t-test of the Target Words in the Knowledge Scale Test were employed.

4.4.1 Results of the Delayed-posttest and a Paired-samples T-test for EG

The delayed-posttest of the target words in the Knowledge Scale Test was conducted four weeks after the post-test. The results of the delayed-posttest for the experimental group are presented in Table 4.8 below. Next, a paired-samples t-test was performed for the experimental group to examine the statistical difference between the mean score of the post-test and that of the delayed-posttest, as shown in Table 4.9 below.

Table 4.8 Descriptive statistics of the delayed-posttest for EG

Test	EG (N=56)	Full points (400)	$\bar{X}$	S.D.
Delayed-posttest	Highest score	331/400	292.22	48.067
	Lowest score	278/400		

EG: Experiment Group; The total scores of the Target Words in the Knowledge Scale Test were 400 points.

Table 4.9 A paired-samples t-test of the post-test and the delayed-posttest for EG

Group	Tests	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
EG (N=56)	Post-test	328.16	44.978	12.215	.229
	Delayed-posttest	292.22	48.067		

EG: Experiment Group (Significant level p<.05); The total scores of the Target Words in the Knowledge Scale Test were 400 points

According to Table 4.8 above, mean of delayed post-test for experimental group was 292.22 (S.D=48.067), with their scores ranging from 278 to 331. Next, as displayed in Table 4.9 above, for the experimental group, its mean decreased from 328.16 on the post-test to 292.22 on the delayed-posttest, which is a reduction of 35.94 (10.95%). Moreover, from a paired-samples t-test, no significant difference between mean of delayed-post-test and that of post-test was identified ($p = 0.229>0.05$). It indicated that experimental students' retention of the words declined slightly after four weeks.

4.4.2 Results of the Delayed-posttest and a Paired-samples T-test for CG

Similarly, after using descriptive statistics, the results of the delayed-posttest for the control group are shown in Table 4.10 below. Then, a paired-samples t-test was conducted for the control group to determine the statistical difference between the mean score of the post-test and that of the delayed-posttest, as shown in Table 4.11.

Table 4.10 Descriptive statistics of the delayed-posttest for CG

Test	CG (N=58)	Full points (400)	$\bar{X}$	S.D.
Delayed-posttest	Highest score	265/400	174.65	36.843
	Lowest score	134/400		

CG: Control Group; The total scores of the Target Words in the Knowledge Scale Test were 400 points.

Table 4.11 A paired-samples t-test of the post-test and delayed-posttest for CG

Group	Tests	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
CG	Post-test	242.20	34.550	21.456	.000
(N=58)	Delayed-posttest	174.65	36.843		

CG: Control Group (Significant level p<.05); The total scores of the Target Words in the Knowledge Scale Test were 400 points.

As revealed by Table 4.10 above, mean of delayed post-test for control group is 174.65 (S.D = 36.843), with their scores ranging from 134 to 265. From Table 4.11 above, mean of control group decreased from 242.20 of the post-test to 174.65 of the delayed-posttest, with a decrease of 67.55 (27.89%). By further analysis of a paired-samples t-test, a significant difference between mean of post-test and that of delayed post-test was detected ($p = 0.000<0.05$). This meant that the control group students' retention of the words declined considerably four weeks later.

4.4.3 Results of an Independent-samples T-test for the Delayed-posttest

An independent-samples t-test was performed to determine the statistical difference between the mean score of the delayed-posttest for the experiment group and

that for the control group. The results of the independent-samples t-test are illustrated in Table 4.12 below.

Table 4.12 An independent-samples t-test of the delayed-posttest for two groups

Test	Group	$\bar{X}$	S.D.	T-value	Sig. (2-tailed)
Delayed-posttest	EG (N=56)	292.22	48.067	32.475	.001
	CG (N=58)	174.65	36.843		

EG: Experiment Group; CG: Control Group; Significant level p<.05 ; The total scores of the Target Words in the Knowledge Scale Test were 400 points.

According to Table 4.12 above, mean of delayed-posttest for experimental group (M=292.22; S.D. = 48.067) is much higher than that of the control group (M=174.65; S.D.=36.843). Through further analysis with an independent-samples t-test, a significant difference was detected on mean of delayed post-tests from two groups ($p = 0.001<0.05$). This means that the students using the app could retain more words than the students who used the paper-based wordlist, suggesting that the app was more effective in students' retention of the words.

4.5 Discussion of the Effects of the App on Vocabulary Retention

As presented above, the app was effective in maintaining students' memory of the words. The results concur well with the findings of the studies (Kohnke et al., 2019; Poláková & Klímová, 2019), which showed that using mobile apps could enhance students' vocabulary retention effectively. Nevertheless, these results are different from the findings of Zhang et al. (2011), which showed that no significant difference was detected on vocabulary retention between the group using SMS (short message service of mobile phones) and the group employing a paper-based wordlist. The reasons could be related to the shortcomings of SMS on mobile phones, which have a limited memory

capacity, difficulties in learning words, and reviewing. In the present study, the three reasons below can be considered as causal factors for a more enduring memory of words among the students using the app.

At first, the spaced review by the retrieval sections of the app probably strengthens students' memory of the words. According to Kang (2016), the spaced vocabulary review means having the initial study and subsequent repetitions of words being spaced over time. In the present study, this spacing was implemented by the students' reviewing the target words four times at intervals of 9 hours, one day, 2 days and six days after they first encountered them in one week. According to the researchers (Daloğlu et al., 2009; Epp & Phirangee, 2019; Kang, 2016; Namaziandost et al., 2019), it was discovered that the spaced repetitions of vocabulary had facilitating influences on transferring learners' knowledge of the learned vocabulary from short term memory to long term memory. Besides, students' spaced review of the exercises in the app would be helpful, as the exercises were part of the vocabulary learning which also led to effective vocabulary retention (Stockwell, 2010; Zimmerman, 1997). Furthermore, these findings are supported by Ma's (2014a) study, which showed that each time the words were retrieved for practice in the students' review, the memory trace for the words would be strengthened. Moreover, it was highlighted that retrieval exercises in the vocabulary review often produce more substantial gains in long-term memory compared to repeated learning (Barcroft, 2006; Candry et al., 2020; Carrier & Pashler, 1992; Roediger & Karpicle, 2005; Roediger & Butler, 2011).

Next, dual coding systems of the words in the app led to better recall. According to Paivio (2007), dual coding systems mean the verbal system and the visual system, which processes, stores linguistics information (such as text and sound) and visual

information (such as pictures and videos), respectively. In addition, three different processing levels: representational, referential, and associative processing, often take place within or between verbal and nonverbal/visual systems to intensify the memory of the information (Clark & Paivio, 1991; Paivio, 1986). Further details can be seen in section 2.1.2. As claimed by Lin (2009), the dual association of verbal and visual modes was very useful in recalling related information, since "when one memory trace is lost, the other remains and is accessible." (p.24). Furthermore, according to Boers et al. (2017), presenting words in two or more modes can attract more attention to the words from EFL students' and hence promotes their retention of vocabulary. They explain further that the visual, as well as verbal illustrations of new words, enhances the quality of processing, and thus makes the words more memorable. These findings substantiate those of Kanellopoulou et al. (2019), which demonstrate that bimodal presentations of new words can improve learners' long-term memory of them.

Finally, students' greater involvement in the exercises of the app resulted in their better retention of the words. As highlighted by Hulstijn and Laufer (2001), the words processed with a greater involvement are retained better than those of their counterparts who processed the words with a lower involvement. This is also supported from the levels of processing theory by Craik and Lockhart (1972), who claimed that the chance of a single piece of information to be stored into the long term memory was decided by its processing levels initially. According to Douglas (2016), ESL students performed better on vocabulary learning with the load of involvement being heavier on task-induced activities. Their long-term retention of vocabulary, however, proved to be relatively limited. The reason might have something to do with the small number of participants, with only five students taking part in the whole process of research.

Moreover, Bagheri et al. (2020) found that Iranian EFL learners' retention of idioms would increase when their involvement load was more engaged in the tasks.

4.6 The Students' Perceptions of the App

To answer the third research question (RQ3): what are the EFL learners' perceptions of vocabulary learning via the mobile app?, the responses from the questionnaire, the interview, and the diaries of the experimental group, were examined together. The results are presented below.

4.6.1 Results of the Questionnaire

The questionnaire was adapted from Chang et al. (2012) and Wang (2015) (see details in section 3.3.5). The questionnaire was valid and reliable, as its content validity was 0.875 and its reliability 0.913. First, according to the students' responses to the questionnaire, the results were obtained using descriptive analysis on SPSS18.0. Then, the results were summarized into five categories, namely, attitudes towards using, perceived convenience, perceived ease of use, perceived usefulness, and continued intention to use, based on the studies of Chang et al. (2012) and Davis (1989). Table 4.13 below shows a summary.

Table 4.13 Responses to the questionnaire with numbers and percentages

Items	Categories (average)	1. Strongly Disagree	2. Disagree	3. Not sure	4. Agree	5. Strongly Agree
4 It is a good method to learn vocabulary via the app.	Attitude towards using (36/50, 72%)	0%	4, 8%	8, 16%	29, 58%	9, 18%
5 I prefer the app to the traditional wordlist for learning vocabulary.		0%	6, 12%	10, 20%	21, 42%	13, 26%
2 Learning vocabulary via the app is convenient, for I can choose place and time to learn new words.	Perceived convenience (42/50, 84%)	0%	2, 4%	10, 20%	27, 54%	11, 22%
11 The app makes vocabulary learning more convenient outside the classroom.		0%	0%	4, 8%	32, 64%	14, 28%
1 The vocabulary learning app is easy to use.	Perceived ease of use (37/50, 74%)	0%	3, 6%	7, 14%	32, 64%	8, 16%
3 The app makes vocabulary learning easier for me, compared with a wordlist.		0%	5, 10%	18, 36%	21, 42%	6, 12%
12 I can learn the words easier based on the images and examples in the app.		0%	3, 6%	4, 8%	29, 58%	14, 28%
6 The vocabulary learning app motivates me to learn new words.	Perceived usefulness (31/50, 62%)	0%	6, 12%	16, 32%	19, 38%	9, 18%
7 The app is useful for me to learn vocabulary.		0%	2, 4%	9, 18%	29, 58%	10, 20%
8 The Learning sections in the app help me learn vocabulary more effectively.		0%	0%	9, 18%	31, 62%	10, 20%
9 The immediate feedback in the app can push me to monitor and adjust my words' learning.		0%	3, 6%	12, 24%	23, 46%	12, 24%
10 The Retrieval sections in the app enable me to review and remember the vocabulary well.		0%	0%	18, 36%	27, 54%	5, 10%
13 The example sentences in the app can consolidate words' knowledge in my mind.		0%	5, 10%	16, 32%	20, 40%	9, 18%
14 The vocabulary learned via the app is not easily forgotten.		0%	7, 14%	29, 58%	12, 24%	2, 4%
15 The example sentences help me learn how to use the words appropriately.		0%	3, 6%	18, 36%	21, 42%	8, 16%
16 In the future, I will continue to use the app to learn vocabulary.	Continued intention to use. (40/50, 80%)	0%	2, 4%	8, 16%	23, 46%	17, 34%

As demonstrated in Table 4.13 above, firstly, 42 out of 50 students (84%) agreed that the mobile app was convenient to use for vocabulary learning, as illustrated by the responses to two items (i.e., items 2 and 11). The number of 84% in the bracket is the mean percentage of the total percentage concerning the choices "agree" and "strongly agree" for items 2 and 11, and this formula is also applicable to the following. In addition, 40 out of 50 students (80%) expressed their intention of continuing to use the app for learning vocabulary in the future, as shown by the responses to item 16. Moreover, 37 out of 50 students (74%) reported that the mobile app made their vocabulary learning easy, as can be seen from the responses to three items (i.e., items 1, 3, and 12). Besides, according to their responses to two items (i.e., items 4 and 5), 36 out of 50 students (72%) held positive attitudes towards the usage of the app. Last, 31 out of 50 students (62%) believed that it was useful to learn and retain the vocabulary by using the mobile app, as demonstrated in the responses to eight items (i.e., items 6, 7, 8, 9, 10, 13, 14, and 15).

4.6.2 Results of the Semi-structured Interview

For the semi-structured interview, eleven questions were from the researcher who referred to the questionnaire of the students' perceptions. The questions in the interview were valid and relevant to the objectives of the present study, since the content validity was 0.88 (see details in section 3.3.6). Next, a thematic analysis was employed to analyze the data from the interview of the present in terms of Dörnyei (2007). To find the themes from the data, the responses of the interviewees were used. In the beginning, 19 students (ten males and nine females) selected on purposive sampling from the experimental group were numbered according to the order of being interviewed. For instance, St.1 stood for the first student to be interviewed. To ensure

the accuracy of the transcriptions and translations by the researcher, the interview conversations were recorded by a digital recorder as well as a notebook, and cross-checked by two experienced English teachers. Later, through thematic analysis, three themes (i.e., fondness, advantages, and challenges of the app) arose from five categories below, which were summarized from the interviewees' responses (Appendix O). Table 4.14 below demonstrates the five categories.

Table 4.14 Categories found from interviewees' responses

Categories (number, percentage)	**Interviewees' responses**
1 Fondness for the app (18, 94.7%)	
-in learning words	*St.19: "...it is easier to learn words with the app than using the traditional word list, so I am fond of it..."*
2 Usefulness/Helpfulness (19, 100%)	
-in understanding and expanding words	*St.9: "...the example sentences make me understand the new words and also expand other words..."*
-in remembering words	*St.5: "...the app left a deep impression on me..."*
-in improving listening	*St.8: "...it can practice and then improve my listening skill..."*
-in adjusting words' learning	*St.13: " ...the feedback made me correct my errors and adjust my learning..."*
-in correcting pronunciation	*St.16: " ...it can improve my pronunciation of words when I read them wrong..."*
-in recalling words	*St.17: "...the relevant pictures and sentences would come to my mind for helping me recall the words..."*
-in practicing four skills	*St.19: "...it can help me practice my speaking, listening, reading and translation..."*
-in arousing interest in learning words	*St.4: "...interesting sentences and pictures of the app arouse my interest in learning the words..."*
3 Convenience (19, 100%)	
-in time	*St.11: "...I can use the fragment time to learn vocabulary via the app...*
-in place	*St.14: "...I can learn words anywhere I want..."*
-in size	*St.1: "...I can learn words conveniently, for it is lighter to carry a mobile phone than to carry a textbook..."*
4 Innovation (17, 89.4%)	
-in the way of learning words	*St.2: "...using this app to learn words is an innovation, for I have never employed such a method for learning vocabulary before..."*

Table 4.14 Categories found from interviewees' responses (Continue)

5 Drawbacks (4, 21.1%)	
-in the irrelevant information popping out	*St.8: "...when I was in the process of learning words via the app, other information popping out distracted me from study..."*
-in the exercise designing	*St.11: "...the exercise of making sentences should be added into the app for strengthening the usage of vocabulary..."*
- in the network connection	*St.13: "...sometimes the network connection was unstable, made me feel frustrated, and then gave up learning words..."*
-in covering the words of textbooks	*St.17: "...it would do me better if textbooks' vocabulary was involved in the app, for I was not ready for CET4 words with low proficiency..."*

Firstly, 18 out of 19 (94.7%) interviewees were fond of the mobile app mainly for its advantages, ranging from the second to the fourth category, as shown in Table 4.14 above. These lend support to the students' responses to the questionnaire concerning their attitudes. Nevertheless, St.7 said

> "*I prefer to use a traditional wordlist to learn words, for I have used it for a long time and am used to it. Besides, there are many temptations in the mobile phone, and it easily distracts me, for I am not a self-disciplined person*".

Next, the three categories showing the advantages of the app and the last category exhibiting the challenges faced by students are displayed as follows.

(1) All interviewees (100%) considered that using the app was useful/helpful in eight aspects, which included: "in understanding and expanding words", "in remembering words", "in improving listening", "in adjusting words' learning", "in correcting pronunciation", "in recalling words", "in practicing four skills", "in arousing interest in learning words". These findings offer vital evidence for the students' responses to the questionnaire regarding the app's usefulness.

(2) All interviewees (100%) regarded the app as convenient for them to learn and review words in three aspects: "in time", "in place", and "in size". These aspects match well with the students' responses to the questionnaire about convenience.

(3) 17 out of 19 interviewees (89.4%) referred to using the app as an innovative way of learning words.

Finally, 4 out of 19 interviewees (21.1%) displayed their challenges by describing the drawbacks of the app, which were “in the irrelevant information popping out”, “in the exercise designing”, “in the network connection”, “in covering the words of textbooks”. In other words, these aspects should be improved in the future.

4.6.3 Results of the Students’ Diaries from EG

Experimental group learners began to keep a diary on the length of time for learning the target words, their feelings concerning their learning words or reviews every week from the second week (W2) to the ninth week (W9). Therefore, eight weeks later, 448 diaries were collected from 56 students of experimental group. Next, the diaries were numbered. The diaries (D) per week (W) in the experimental group (EG) were numbered in ascending order of students’ ID numbers, such as D1W2EG, D2W2EG, D3W2EG..., D1W3EG, D2W3EG, D3W3EG..., and the like. For instance, the code D1W2EG meant the first student’s diary in the second week from the experimental group, and D1W3EG meant the first student’s diary in the third week from experimental group, and the like.

Then, the diaries were first translated from Chinese into English by the researcher and then the translations were cross-examined by two experienced English teachers. Later, the translations of the diaries were grouped and categorized to form themes. Table 4.15 below demonstrates the length of time, study time, and the feelings expressed in the diaries of the experimental group (Appendix P).

Table 4.15 Time length, studying time for 10 words/week, and feelings from EG

Times/ week	**The 1st time**	**The 2nd time**	**The 3rd time**	**The 4th time**	**The 5th time**	**Total time /week**
Average time length (minutes)	20	18	17	10	10	75
Studying time (number, percentage)	**Students' writings**					
-in early morning (43, 76.7%) -between two classes (34, 60.7%) -during meals (35, 62.5%) -while going-out (45, 80.4%) -late at night (51, 91.1%)	*D6W2EG:"...when I woke up at 6:00 a.m. before getting up, I would switch on smartphone and use the app to learn words..."* *D28W5EG:"...usually I use the app to review words during the 20 minutes' break time between two classes..."* *D31W4EG:"...I often learn the words through the app while I am queuing or eating in the canteen..."* *D18W9EG:"...when I go outside and take a bus, I like using the app to learn words to kill time..."* *D42W7EG:"...After 11:00 P.M., I got on the bed and could not fall asleep easily. Then I turned on the smartphone to learn words via the app..."*					
Feelings by category (number, percentage)	**Students' writings**					
1 Preferable (46, 82.1%) -in memorizing words	*D54W6EG:" ...I prefer the app, for it helps me remember many words..."*					
2 Convenient (51, 91.1%) -in time and place	*D39W3EG:"...as long as the smartphone is on me, I can learn and review words via the app anytime anywhere..."*					
3 Effective (44, 82.1%) -in memory of words	*D31W2EG:"...words are memorized repeatedly, which effectively enhances the memorization of the word..."*					
4 Reasonable (50, 89.3%) -in learning 10 words at a time -in a 5-time schedule per week	*D31W2EG:"...using the app to learn 10 words per time outside the class is reasonable and easy..."* *D38W5EG:"...The teacher gave us the five-time schedule of the app so that we didn't have any pressure to learn words..."*					
5 Satisfied (41, 73.2%) -with an increase in vocabulary size	*D6W7EG:"...It's another full week, and my vocabulary size increases day by day. I feel very satisfied..."*					
6 Fun (43, 76.8%) -in the process of learning words -in the process of remembering words	*D14W8EG:"...in the process of learning words, this app will alleviate the boring of learning words and add more fun..."* *D8W5EG:"... I feel that memorizing words via the app has become a fun thing, easy and fun..."*					
7 Easy (38, 67.9%) -in memorizing words	*D46W9EG:"...I feel easy to memorize words through the app. The Words which once cost me a long time to memorize only need a while to remember now..."*					
8 Useful (47, 83.9%) -in the pronunciation of words -in increasing interest in English -in memorizing words -in increasing confidence in English	*D31W3EG:"...using the app to review words could correct my pronunciation..."* *D43W4EG:"...after using the app for three weeks, my interest in English learning is much improved..."* *D38W5EG:"...I think using this app to memorize words is very helpful..."* *D25W2EG:"...After using the app, my heart has lighted a raging fire, and my confidence in English comes back..."*					
9 Willing to persist (46, 80.6%) -in learning words via the app	*D32W6EG:"...after studying for a few weeks, memorizing words is getting easier, and more vocabulary is accumulated. I will persist in learning words via the app..."*					

Table 4.15 Time length, studying time for 10 words/week, and feelings from EG (Continue)

Times/ week	**The 1st time**	**The 2nd time**	**The 3rd time**	**The 4th time**	**The 5th time**	**Total time /week**
Average time length (minutes)	20	18	17	10	10	75
Studying time (number, percentage)	**Students' writings**					
10 Difficult (11, 19.6%) -in sticking to the schedule during military training -in remembering the pronunciations and meanings of all words -in recalling the words	*D43W4EG:"...Because of military training*[1]*, the arrangement each day was full. It was very difficult to stick to the five-time schedule to learn words..."* *D24W6EG:"...but it was difficult to remember the pronunciation and meanings of every word completely..."* *D52W7EG:"...I felt I could not recognize the words after seeing them if I switched off the smartphone..."*					

As displayed in Table 4.15 above, the students' length of time spent on the ten words was 15 minutes per time making a total of 75 minutes every week. Next, their studying time ranged from early morning to late in the evening. To be precise, the popularity of the students' study time via the app ranked from high to low was "late at night" (51, 91.1%), "while going-out" (45, 80.4%), "in early morning" (43, 76.7%), "during meals" (35, 62.5%), "between two classes" (34, 60.7%).

Furthermore, with respect to students' feelings about the app, four themes (i.e., preference, merits, willingness to persist, difficulties in using the app) are formed from nine categories of their diaries, which are displayed as follow.

First, 46 out of 56 students (82.1%) showed their preferences for the app, because they felt it was "convenient" "effective", "reasonable", "satisfying", "fun", "easy", "useful". in learning and remembering the words via the app. These findings further confirm the students' positive attitudes towards the app which were found from the questionnaire and the interview. Next, the seven categories about the merits of the

1. In China, every newcomer in the university has to take military training, which often lasts from two weeks to four weeks. It usually begins in September of the first semester. During the military training, all courses of the freshmen stop, and all they have to do is to take the military training led by military instructors from 6:00 a.m. to 9:00 p.m. every day with several breaks a day.

app are presented as follows.

(1) 51 out of 56 students (91.1%) thought it was convenient to learn and review words via the app.

(2) 44 out of 56 students (78.6%) described the app as effective in enhancing their memory of words.

(3) 50 out of 56 students (89.3%) believed that it was reasonable for them to learn 10 words via the app independently using the 5-time schedule within one week.

(4) 41 out of 56 students (73.2%) expressed their satisfaction with the app, for they could feel their vocabulary size increasing after using the app.

(5) 43 out of 56 students (76.8%) mentioned that learning and memorizing words via the app was enjoyable for them.

(6) 38 out of 56 students (67.9%) claimed that they felt that it was easy to keep the words in mind through the app.

(7) 47 out of 56 students (83.9%) perceived the app as useful in correcting the pronunciation of words, increasing their interest in English, memorizing words, and improving their confidences in English.

Additionally, 45 out of 56 students (80.6%) expressed their willingness to persist in using the app in the future.

Finally, 11 out of 56 students (19.6%) mentioned their difficulties in using the app while following the schedule during military training, remembering the pronunciations and meanings of all the words, and recalling the words.

4.7 Discussion on the Students' Perceptions of the App

First, according to the students' responses to the questionnaire, it was discovered that 36 out of 50 students (72%) held positive attitudes towards the app. This finding is supported by 18 out of 19 interviewees (94.7%), who showed their fondness for the app. Also, 46 out of 56 students (82.1%) mentioned in their diaries that they preferred learning and remembering vocabulary via the app. These findings match well with the studies (Bensalem, 2018; Deris & Shukor, 2019; Gonulal, 2019; Klimova & Polakova, 2020; Kohnke, 2020; Ornprapat & Wiwat, 2015), which revealed that most of EFL students held positive attitudes towards learning EFL vocabulary helped by mobile apps. Additionally, according to Creswell and Creswell (2017), the triangulation of data from multiple sources: the questionnaire, interview, and diary, can ensure the internal validity of the data. Therefore, the reasons for the students' positive attitudes towards the app from the questionnaires, interviews, and diaries, were reliable. They are further discussed as follows.

(1) According to the results from the questionnaire, interview, and diaries, one common reason, the convenience of the app, is mentioned, although the amount and percentage of students expressing this view are slightly different (42 of 50 students or 84% from the questionnaire; 19 interviewees or 100% from the interviews; 51 of 56 students or 91.1% from the diaries). As shown by Kim et al. (2013), students' positively accepted the use of mobile apps for language learning, for many conveniences offered by the apps increased their learning opportunities. Also, Soleimani et al. (2014) ascertained positive responses from EFL students to a mobile app due to its great convenience. Moreover, Deris and Shukor (2019) discovered that their students considered it convenient to learn EFL vocabulary via a mobile app, since it was

accessible in any place and at any time. As a consequence, they were able to use the app based on their preferred place and time, which made their vocabulary learning very effective. The findings above are further confirmed by Klimova and Polakova (2020), who highlighted that EFL students appreciated the convenient accessibility of learning vocabulary with smartphone apps more than with the traditional textbooks. Additionally, Kohnke (2020) disclosed that EFL university students regarded the anytime, anywhere flexibility of the app as strengths to learn vocabulary, which they often employed on the way to university.

(2) 37 of 50 students (74%) from the questionnaire and 44 of 56 students (78.6%) from the diaries claimed that it was easy and fun to learn and review vocabulary via the app. As identified by Wang (2015), Thai EFL students found the mobile app attractive and interesting for learning vocabulary. One reason why mobile learning had a positive effect on students' engagement was provided by Hargis et al. (2014), who explained that mobile technologies brought EFL learners' more fun and thus motivated them to more proactive involvement. Also, Kwangsawad (2019) stated that EFL students found employing smartphones more fun and productive in English classes. Additionally, the students liked using the mobile app to learn new EFL words, since they felt that learning words from the app rather than from textbooks was more fun, less stressful, and easier to use (Klimova & Polakova, 2020).

(3) The usefulness/helpfulness of the app was identified from 31 of 50 students' responses to the questionnaire (74%), 19 interviewees (100%), and 47 of 56 students' diaries (83.9%). According to Tabatabaei and Goojani (2012), the app short message service (SMS) of mobile phones was useful in facilitating EFL vocabulary learning among Iranian high school learners. Similarly, Ornprapat and Wiwat (2015) found that

the app SMS of mobile phones helped contribute to the success of Thai EFL students' vocabulary learning and increased their learning motivation. Similarly, Makoe and Shandu (2018) learnt that the self-developed mobile app was helpful in enhancing EFL learners' vocabulary learning and forming their habits of autonomous learning in South Africa. Next, exploring the experiences of Chinese older adults' (aged from 45 to 85) learning EFL vocabulary with various mobile apps, Wang and Christiansen (2019) revealed that using mobile apps was very useful in improving their vocabulary and motivation for learning English. This lends support to the studies of Yu (2019) and Chen (2020), who found that using mobile technologies could increase learners' confidence and motivation in learning a foreign language.

(4) 17 of 19 interviewees (89.4%) regarded it as innovative to learn vocabulary via the app. As demonstrated by Basal (2012), mobile learning can enrich EFL traditional teaching and learning methods creatively by setting a flexible, hands-on way learning both inside and outside the classroom. Pavlik (2015) argued that mobile technologies were transforming teaching and learning methods by challenging educational notions of space, time, content, processes, and outcomes. As a result, teachers and learners were experiencing innovative changes, which included the direction of communication, interactivity, the media of teaching and learning, the constraints on the learning process and output. Next, Sung et al. (2016) showed that MALL had great potential for reforming teaching and learning methods with innovations. This is consistent with the study of Basal et al. (2016), which identified that using apps was innovatively shaping the way EFL teachers taught and students learned by offering them many new opportunities. Moreover, it was revealed that learning vocabulary via the mobile app provided an innovative opportunity and experience for Saudi Arabian EFL students

(Shahbaz & Khan, 2017).

(5) 44 of 56 students (82.1%) in the diaries described the app as effective. Hu (2013) argued that regular SMS (Short Message Service) on mobile phones might act as an effective way for EFL learners to exercise their autonomous vocabulary learning. As noted by Rezaei et al. (2014), it was an effective way to improve EFL vocabulary learning through the mobile app, for it helped visualize the meanings of words by multimedia and hence left a deep impression on them. Next, Wu (2015) attested that the self-developed app was effective in facilitating Chinese EFL learners' vocabulary learning in a natural environment with its great convenience and easiness. Also, it was discovered by Ma (2019) that the dictionary apps could significantly improve the efficiency of ESL learners' vocabulary learning by offering multiple functions and rich resources. Moreover, EFL learners felt that it was challenging and time-consuming to learn academic EFL vocabulary, yet they felt that mobile apps could enhance their academic vocabulary learning more efficiently (Kohnke, 2020).

(6) 50 of 56 students (89.3%) in the diaries mentioned that it was reasonable for them to learn ten words at one time five times per week with the mobile app. As claimed by Paas et al. (2004), working memory (short-term memory) could only perform a few tasks or hold a limited number of information each time. Undertaking more information than working memory can process at one time would lead to memory fatigue or even failure (Ginns, 2006; Merckelbach et al., 2000). Other causes might be that the limits of short-term memory capacity for an adult were seven $\pm$ two objects (Miller, 1956), and that learners' working memories were more likely to experience confusion with a high cognitive load induced by dealing with many objects at one time (Sweller, 2016). In addition, according to Nation (1990, 2001), EFL learners needed to be exposed to a

word 5-16 times to acquire it thoroughly, and frequent re-encountering of the word was crucial for learners to keep the vocabulary in long-term retention. Thornbury (2002) stated that one important factor that improved retention was spaced learning of the words. This means that the words learned over spaced periods were kept better than those counterparts learned in concentrated bursts. This is verified by the findings of Thornton and Houser (2005) that spaced practice exhibited more beneficial impacts on vocabulary learning and retention than massed practice.

(7) 41 of 56 students (73.2%) in the diaries wrote that they were satisfied with the app. Santos et al. (2016) highlighted that EFL learners with various mother languages were satisfied with an Augmented Reality (AR)-based app as it enabled better retention of words. Next, as discovered by Wang (2017), Taiwanese EFL learners were satisfied with her self-developed app to learn vocabulary because they found it relaxing and convenient. By developing an Augmented Reality (AR) app for Malaysian EFL learners, Che Hashim et al. (2018) found that students and teachers were content with the app due to its learnability and ease of use. Additionally, it was noted that EFL university students were satisfied with a mobile game-based English vocabulary learning app because they enjoyed using it and became more involved (Chen et al., 2019). Moreover, Kohnke (2020) found that in general EFL students were satisfied with the app to learn vocabulary.

(8) 40 of 50 students (80%) from the questionnaire and 46 of 56 students (80.6%) in the diaries expressed their willingness to persist in using the app to learn vocabulary in the future. As identified by Kim et al. (2013), ESL learners became more willing to use mobile technologies for English learning in their lives, since it could bring them many learning opportunities. Wang et al. (2015) found that EFL learners' willingness

to use the Word-power app for future study was influenced by their classroom learning experience. In addition, according to Wang and Hsu (2020), EFL learners' future behavioral intentions closely correlated with their satisfaction with the app. In other words, when the learners were satisfied with the app, they were more likely to continue to use it in the future.

Nevertheless, 4 of 19 interviewees (21.1%) mentioned the drawbacks of apps, and 11 of 56 students (19.6%) described their difficulties in using the app. As argued by Wang and Higgins (2006), the barriers that constrained the use of mobile technologies for language learning were related to psychological, pedagogical, and technological factors. They also claimed that it was time-consuming for EFL learners to embrace mobile technologies, and that it was impossible to expect all of them to accept mobile-assisted language learning at the same pace. The disadvantage of using mobile apps for language learning identified in the studies (Li & Li, 2011; Viberg & Grönlund, 2013) was that some students might be distracted easily from unrelated information on their smartphones or prefer to do something else. Besides, challenges concerning the costs of the internet and mobile devices for language learning were faced by parents, students, teachers, and educational institutions (Oberg & Daniels, 2013; Oz, 2014). Additionally, Wu (2015) pointed out that a lack of interaction and updating of contents were two shortcomings of the app she developed for EFL vocabulary learning. It was discovered that one limitation affecting the usability of mobile technologies for language learning was the dependency on networks (Elaish et al., 2017). This is substantiated by Makoe and Shandu (2018) who explained that EFL learners would experience frustration and barriers hindering their vocabulary learning when there was no network or the internet unstable. Moreover, as revealed by Taghizadeh and Porkar (2018), the reasons for the

negative attitudes of some students towards using mobile technologies for EFL vocabulary learning could be the result of technical problems, the small batteries on mobile devices, and the possible harm to their eyes.

4.8 Results of the Diaries from CG and Discussion

Like students of experimental group, control group counterparts also wrote diaries on the time length of their learning target words, their feelings about the learning words or reviews every week from the second week (W2) to the ninth week (W9). Consequently, 464 diaries were collected from 58 students of the experimental group after eight weeks. Then, the diaries were numbered. The diaries (D) per week (W) in the control group (CG) were numbered in ascending order of students' ID numbers, such as D1W2CG, D2W2CG, D3W2CG..., D1W3CG, D2W3CG, D3W3CG..., and the like. For example, the code D1W2CG meant the first student's diary in the second week from the control group, and D1W3CG meant the first student's diary in the third week from the control group, and the like.

Later, the diaries were translated from Chinese into English by the researcher and then cross-checked by two teachers with college English teaching experiences. Next, the translations were grouped and categorized into themes. Table 4.16 illustrates the length of time for studying found from the students' diaries of the control group.

Table 4.16 Time length, studying time for 10 words/week from CG

Times/ week	**The 1st time**	**The 2nd time**	**The 3rd time**	**The 4th time**	**The 5th time**	**Total time /week**
Average time length (minutes)	18	17	16	14	15	80
Studying time (number, percentage)	**Students' writings**					
-before the first class of the day (48, 82.6%) -after class and before meals (41, 70.7%) -during the night (50, 86.2%)	*D7W4CG: "...I often use the time before the first class beginning to recite the wordlist on the paper sheet..."* *D16W3CG: "...after class, I usually spent some time on the wordlist before I went to the crowded canteen..."* *D43W7EG: "...After having dinner, I prefer to go to the library to recite the wordlist ..."*					

As shown in Table 4.16, the length of time students spent on the ten words was 16 minutes per time which made a total of 80 minutes every week. Next, the study time of the control group varied from morning to night. Table 4.17 below presents the similarities and differences on the length of time and studying time between the two groups.

Table 4.17 Similarities/differences on time length, studying time of two groups

Groups	**Times/week**	**The 1st time**	**The 2nd time**	**The 3rd time**	**The 4th time**	**The 5th time**	**In total**
EG	Time length (minutes)	20	18	17	10	10	75
CG		18	17	16	14	15	80
		Studying time (number and percentage, ranking from high to low)					
EG		Late at night (51, 91.1%)	During going-out periods (45, 80.4%)	In early morning (43, 76.7%)	During the meals (35,62.5%)	Between two classes (34, 60.7%)	
CG		During the night (50, 86.2%)	Before the first class of the day (48, 82.6%)	After class and before meals (41, 70.7%)			

According to Table 4.17 above, the average length of time spent on the ten words by the experimental group was 15 minutes at a time, which was close to that of the

control group (16 minutes/time). Next, the students of the experimental group spent 75 minutes in total on the ten words every week, which was a similar amount of time to that of the control group (80 minutes/week). Nevertheless, the periods of study time for experimental group were more varied than control group, which suggests that the app was more convenient than the paper-based wordlist for learning the target words.

Table 4.18 Students' feelings about the paper-based wordlist from CG

Feelings by category (number, percentage)	**Students' writings**
1 Good (36, 62.1%)	
-with the five-time schedule	*D14W2CG: "...when I first saw the words, I had a strong sense of strangeness. By the third time, I became familiar with the words, and I remembered the words. By the fifth time, I was completely familiar with them. So this five-time schedule was good for us to be familiar with the words..."*
2 Tedious (38, 65.5%)	
-in learning words	*D33W5CG: "...it was annoying and painful for me to spend much time learning the wordlist..."*
-in reviewing words	*D40W3CG: "...the review process with the wordlist is boring..."*
3 Weak (42, 72.4%)	
-in retaining words	*D5W3CG: "...The meaning of words was easy to be confused with others. Hence it was difficult to remember the words. Missing or reversed letters often happened to me when I tried to spell the words..."*
-in efficiency	*D51W5CG: "...I found that I learned vocabulary slowly and forgot them quickly. The efficiency of memorizing words with the wordlist was very low..."*
-in pronouncing words	*D10W2CG: "...when reading words, I felt my tongue was not smooth. And the pronunciation of the words was challenging for me, and it was not accurate..."*

Furthermore, as illustrated by Table 4.18, three categories: satisfaction with the five-time schedule, tediousness, and weaknesses of the paper-based wordlist, are summarized from the students' diaries of the control group (Appendix Q). First, 36 of 56 students (62.1%) mentioned that it was good for them to learn the ten words according to the five-time schedule. This is consistent with the findings of previous

studies (e.g. Ginns, 2006; Merckelbach et al., 2000; Miller, 1956; Nation, 1990, 2001; Sweller, 2016; Thornbury, 2002; Thornton & Houser, 2005), who revealed that it was reasonable for language learners to learn a small number of words at a time based on a spacing effect (see details in No.6 of section 4.7).

Next, 38 of 58 students (65.5%) considered it tedious to learn and review vocabulary using the paper-based wordlist. According to Hanafiah (2015), the students became bored easily with learning from a wordlist and then lost interest in vocabulary learning or even in studying English as a subject. As pointed out by Gadanecz (2018), EFL students considered it dull to learn vocabulary with the paper-based wordlist, which had a negative influence on their self-efficacy and motivation for language learning. Also, it was found that the Iranian EFL students of the control group perceived wordlists as a tedious method to learn vocabulary (Taghizadeh & Porkar, 2018). Additionally, accrording to the pilot study of the researcher, it showed that EFL learners were likely to feel stressed and tired from looking at wordlists, especially long wordlists from English textbooks, which could affect their learning motivation.

Lastly, 42 of 58 students (72.4%) claimed that they felt there were three weaknesses in learning paper-based wordlists, which were their retention of the words, learning efficiency, and pronunciation of the words. These findings concur with the study of Mondria and Wit-de-Boer (1991), who found that memorizing vocabulary by using wordlists caused them to become confused and forgetful. Also, Oxford and Scarcella (1994) disclosed that only offering students a wordlist was undoubtedly not an effective method for vocabulary instruction. This is confirmed by Zheng et al. (2015), who demonstrated that it was not effective for Chinese EFL university students to memorize new words using the traditional method of wordlists. Additionally, Icht and

Mama (2019) found that the non-production of words (words read silently) was less durable and showed more memory decay than the production of words (words read out) over time. So it can be deduced that the weakness of the students' pronouncing words from a wordlist could negatively influence their vocabulary learning and memory. However, Nation (1993) and Clipperton (1994) argued that learners could directly remember the spelling, pronunciation, and meanings of the words on a wordlist. The reason for this may be that the learners received help with the pronunciation when learning the words, while learners of control group in the study had to learn the wordlist by themselves.

4.9 Summary of the Results and Discussion

To sum up, the result of an independent-samples t-test showed that a statistically significant difference was detected on the post-test between the control group and the experimental group. It indicated that students achieved more words via the mobile app compared with those from the control group, and demonstrated that the app was more effective than paper-based wordlist in improving students' vocabulary learning. These are in line with the findings of the studies (Bensalem, 2018; Chen et al., 2019; Poláková & Klímová, 2019; Wang & Shih, 2015). Besides, the students' more vocabulary achievements via the app could be due to four aspects, which referred to the multimedia environment (Al-Seghayer, 2016; Gonulal, 2019; Kim & Gilman, 2008; Matsuoka & Hirsh, 2010; Mayer, 1997; Mayer & Fiorella, 2014; Ramezanali, 2017; Rusanganwa, 2015), the immediate corrective feedback (Henderson, 2019; Mollakhan et al., 2013; Pashler et al., 2005; Roediger & Butler, 2011; Soria et al., 2020; Sprenger, 2018), the enjoyment induced by the app (Green, 1993; Hsu et al., 2017; Sandberg et al., 2011),

the audios of words in the app (Celce-Murcia, 2001; He et al., 2015; Hennings, 2000; Kaplan-Rakowski & Loranc-Paszylk, 2019; Karousou & Nerantzaki, 2020; Laufer, 1998; McCarthy, 1994; Min, 2013; Trofimovich & Issacs, 2012).

Secondly, the results of the delayed-posttest disclosed that the students' retention of the words decreased for both groups. The paired-samples t-test for the experimental group showed an insignificant difference between the post-test and the delayed-posttest, suggesting a slight reduction of words memory. However, through the paired-samples t-test for the control group, a significant difference was detected between the post-test and the delayed-post-test, indicating a considerable memory decay of words. By a further independent-samples t-test, a statistically significant difference was identified on the delayed-posttest between the two groups. This meant that the students using the app could retain more words than the students employing the paper-based wordlist, indicating that the app was more effective in maintaining students' retention of the words. These findings are consistent with those of the studies (Kohnke et al., 2019; Poláková & Klímová, 2019). In addition, three factors may account for students retaining more words by using the mobile app, which were the spaced review (Barcroft, 2006; Candry et al., 2020; Carrier & Pashler, 1992; Daloğlu et al., 2009; Epp & Phirangee, 2019; Kang, 2016; Namaziandost et al., 2019; Roediger & Karpicle, 2005; Roediger & Butler, 2011; Stockwell, 2010; and Zimmerman, 1997), dual coding systems of the words (Boers et al., 2017; Clark & Paivio, 1991; Kanellopoulou et al., 2019; Lin, 2009; Paivio, 1986, 2007), the involvement loads induced by the exercises (Bagheri et al., 2020; Craik & Lockhart,1972; Douglas, 2016; Hulstijn & Laufer, 2001).

Thirdly, 36 of 50 students (72%) held positive attitudes towards the app based on their responses to the questionnaire. Also, 18 out of 19 interviewees (94.7%) showed

that they liked the app. Also, 46 out of 56 students (82.1%) mentioned in their diaries that they preferred the app. These findings lend support to previous studies (Bensalem, 2018; Deris & Shukor, 2019; Gonulal, 2019; Klimova & Polakova, 2020; and Ornprapat & Wiwat, 2015), which reported that most of the students held positive attitudes towards using mobile apps to learn EFL vocabulary. Additionally, the reasons why most students held positive attitudes towards the app could be the convenience (Deris & Shukor, 2019; Kim et al., 2013; Klimova & Polakova, 2020; Soleimani et al., 2014;), ease and enjoyment of use (Deris & Shukor, 2019; Hargis et al., 2014; Klimova & Polakova, 2020; Kwangsawad, 2019; Wang, 2015), the usefulness of the apps (Chen, 2020; Makoe & Shandu, 2018; Ornprapat & Wiwat, 2015; Tabatabaei & Goojani,2012; Wang & Christiansen, 2019; Yu, 2019), their innovative features (Basal, 2012; Basal et al., 2016; Pavlik, 2015; Shahbaz & Khan, 2017; Sung et al., 2016), their effectiveness (Hu, 2013; Ma, 2019; Rezaei et al., 2014; Wu, 2015), their practicality (Ginns, 2006; Merckelbach et al., 2000; Nation, 1990, 2001; Paas et al., 2004; Sweller, 2016), their satisfaction (Che Hashim et al., 2018; Chen et al., 2019; Santos et al., 2016; Wang, 2017), and their willingness to persist in using the app (Kim et al., 2013; Wang & Hsu, 2020; Wang et al., 2015).

Fourthly, 4 of 19 interviewees (21.1%) mentioned the drawbacks of the app, and 11 of 56 students (19.6%) described their difficulties in using the app. The reasons for this may have something to do with psychological factors (Wang & Higgins, 2006), the easily distracted attention (Li & Li, 2011; Viberg & Grönlund, 2013), the costs of mobile devices and of the internet usage (Oberg & Daniels, 2013; Oz, 2014), the lack of interaction and of the contents' updating (Wu,2015), the technical problems (Elaish

et al., 2017; Makoe & Shandu, 2018; Taghizadeh & Porkar, 2018), and the possible damage to their eyes (Taghizadeh & Porkar, 2018).

Lastly, as regards the control group, 38 of 58 students (65.5%) considered it tedious to learn and review vocabulary using the paper-based wordlist. The reasons for this could be that they found the wordlist boring (Gadanecz, 2018; Hanafiah, 2015; and Taghizadeh & Porkar, 2018), and the stress, as well as the tiredness induced by the wordlist found from the pilot study of the researcher. Furthermore, 42 of 58 students (72.4%) pointed out the weaknesses of learning vocabulary by using a paper-based wordlist, which were the difficulty in retaining words (Mondria & Wit-de-Boer, 1991), the low efficiency of the wordlist (Oxford and Scarcella, 1994; Zheng et al., 2015), and the lack of help in learning how to pronounce the words (Icht & Mama, 2019).

chapter five includes the conclusion, implications, and recommendations.

CHAPTER 5

CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

This chapter is organized into four sections. Firstly, the procedure and the main findings of the current study are presented. Then, the implications of the present study are shown. Next, the recommendations for further research are proposed. Lastly, a summary of this chapter is given.

5.1 Conclusion of the Study

The study was proposed and done for the purpose of adding to the existing research on mobile app-assisted vocabulary learning in this mobile technology-driven era. A mobile app was developed especially for the vocabulary learning of Chinese EFL learners which was based on four theories: the ten design principles for MALL (Stockwell & Hubbard, 2013), the dual coding theory (Paivio, 2007, 1986, 1971), the cognitive theory of multimedia learning (Mayer, 2014), and the memory-based strategic framework for vocabulary learning (Ma, 2014a). Then, together with exploring the effectiveness of the app on students' vocabulary learning and retention, their perceptions of the app were probed. Next, a mixed methods approach was used to collect data in the study. A quantitative methodology was employed to assess the students' vocabulary size in a pretest, their knowledge of the target words from the pretest, post-test and the delayed-posttest, as well as their perceptions of the mobile app.

In addition, in order to triangulate the students' performances above, a qualitative method was applied to analyze the data from the interview and the diaries in terms of Creswell and Creswell (2017). Moreover, to achieve the objectives, three research questions were formulated as below.

1) What are the effects of using the theory-based mobile app on EFL students' vocabulary learning achievement?

2) What are the effects of employing the theory-based mobile app on EFL students' vocabulary retention?

3) What are the EFL learners' perceptions of vocabulary learning via the theory-based mobile app?

To answer the research questions, a quasi-experimental design was made for the study. The duration of the experiment was 14 weeks throughout the first semester of the academic year 2019. First, two classes were chosen to be the participants based on convenience and availability. One Secretary class with 56 students was assigned as the experimental group and a Chinese Language class with 58 counterparts as the control group at random. Then, in week 1, the two groups were briefed in the classroom about the purpose of the study. Next, in the same week, after both groups had finished the Vocabulary Size Test (VST) and the Vocabulary Knowledge Scale (VKS), the mobile app with eight packages of 80 target words was introduced and then installed into the smartphones of the experiment group. In contrast, the wordlists of the same eight packages on paper sheets were given out for control group weekly.

Moreover, from the second week on, both groups started to learn one package of ten words by the proposed schedule on their own every week. Also, the diaries of both groups about the time for learning and the students' feelings were collected once a week.

Eight weeks later, in week 10, both groups completed the VKS as in the pretest. In the same week, the students from the experiment group finished the questionnaire, and in terms of their responses to the questionnaire and the diaries, 19 participants were selected purposely and interviewed individually. Additionally, four weeks later, both groups took the delayed-posttest. Lastly, after the data was collected, descriptive statistics, the independent-samples t-test, and the paired-samples t-test were performed by SPSS 18.0 to analyze the quantitative data. Next, the data from the semi-structured interview, as well as the diaries, were analyzed qualitatively.

The main findings of the current study can be summarized as follows.

Firstly, the mobile app was more effective in improving students' vocabulary learning than a paper-based wordlist. This concurs well with a recent study of Poláková and Klímová (2019), which revealed that the experimental group using a mobile app learnt more words than the control group using traditional methods. In the present study, four main reasons may account for the experimental students' higher achievements in vocabulary learning.

(1) The multimedia environment in the app had the advantages of facilitating students' understanding of the words quickly, helping them learn faster, and strengthening their memory of the words. These are consistent with the findings of the studies (e.g. Al-Seghayer, 2016; Gonulal, 2019; Govindasamy et al., 2019; Matsuoka & Hirsh, 2010; Mayer & Fiorella, 2014; Ramezanali, 2017; Rusanganwa, 2015).

(2) Corrective feedback in the app was offered promptly which was useful in helping students' to adjust their methods and timing for vocabulary learning, and memorizing the correct meanings as well as the forms of words. As demonstrated in the studies (Henderson, 2019; Soria et al., 2020; Sprenger, 2018), instant corrective

feedback helped students' considerably in monitoring their vocabulary learning and correcting any mistaken guesses before they stored their vocabulary knowledge correctly.

(3) The enjoyment from using the app motivated and increased students' vocabulary learning, which resulted in more significant achievements in their vocabulary learning. This lends support to the studies by Green (1993) and Poláková and Klímová (2019), which indicated that the enjoyment of using mobile apps could enhance their effectiveness in learning.

(4) The audio recordings of words in the app improved students' pronunciation, which led to improved vocabulary learning. According to the researchers (He et al., 2015; Kaplan-Rakowski & Loranc-Paszylk, 2019; Karousou & Nerantzaki, 2020; Trofimovich & Issacs 2012), by listening to audio recordings of words, students would improve pronunciation, which was likely to facilitate their memorizing and retrieval of the words.

Secondly, the students using the app retained more words than those using the paper-based wordlist in the long term. This result is in agreement with other studies (Kohnke et al., 2019; Poláková & Klímová, 2019), which revealed that using mobile apps could enhance students' vocabulary retention effectively over time. In the present study, this may be attributed to three reasons as follow.

(1) The spaced review of the exercises in the app strengthened the words in students' long-term memories. This is consistent with the research findings (Candry et al., 2020; Daloğlu et al., 2009; Epp & Phirangee, 2019; Ma, 2014a; Namaziandost et al., 2019), which substantiated that spaced repetitions of retrieval had a positive impact on transferring vocabulary knowledge from the short-term to the long-term memory.

(2) Dual coding of the words in the app contributed to better recall of them. This corroborates the studies (Clark & Paivio, 1991; Lin, 2009; and Paivio, 1986, 2007), which showed that the words presented in both verbal and visual modes were recalled effectively because "when one memory trace is lost, the other remains and is accessible" (Lin, 2009, p.24).

(3) More involvement loads induced by the exercises of the app resulted in their better retention of the words. These are line with the findings of the studies (Bagheri et al., 2020; Craik & Lockhart, 1972; Douglas, 2016; Hulstijn & Laufer, 2001), which unveiled that learners' retention of words become higher with increasing involvement loads induced by the tasks (exercises).

Thirdly, based on students' responses obtained from the questionnaire, it was highlighted that 77% of the students held positive attitudes towards app-assisted vocabulary learning. This is verified by the 18 interviewees' responses of their 19 counterparts and 82.1% of the students' diaries from the experimental group. Also, the results above match well with the findings of other studies (Bensalem, 2018; Gonulal, 2019; Kohnke, 2020; Ornprapat & Wiwat, 2015). To analyze these responses more closely, six advantages may explain why most of the students liked the app in the present study: they were 'convenient' (Godwin-Jones, 2008; Huang et al., 2012; Jee, 2011; Kohnke, 2020; Ma, 2019; Younus, 2014), 'easy' (Wang, 2015), 'useful' (Kim, 2011, 2013; Ornprapat & Wiwat, 2015; Wang & Christiansen, 2019; Tabatabaei & Goojani, 2012), 'entertaining' (Başoğlu & Akdemir,2010; Aga & Özdemir, 2013; Poláková & Klímová, 2019), 'effective' (Basal et al., 2016; Gonulal, 2019; Ma, 2019; Kohnke, 2020), and 'increasing confidence and motivation in English' (Chen, 2020; Yu, 2019).

At last, three weaknesses with the paper-based wordlist learning were disclosed by the present study, which were in the following. a) Students considered it difficult to clearly remember the words because they were often confused between different words and some were lost from memory. This verifies the study of Mondria and Wit-de-Boer (1991), which highlighted that remembering vocabulary using a wordlist easily led to confusion and even memory loss. b) The efficiency was low in learning vocabulary with the wordlist. This is supported by Zheng et al. (2015), who revealed that the traditional mode of learning words from a wordlist made university EFL students learn slowly and forget quickly. c) The students' difficulties in pronouncing the words negatively affected their memory of the learned words. This confirms the study of Icht and Mama (2019), which found that the non-production of words (words read silently) was less durable in the memory, and showed more memory decay than the production of words (words read out) over time. However, Clipperton (1994) and Nation (1993) claimed that learners could directly remember the spelling, pronunciation, and meanings of the words from a wordlist. The possible reason was that the students received help with the pronunciation when they were learning words in the studies of Clipperton (1994) and Nation (1993).

5.2 Pedagogical Implications from the Present Study

As the present study has examined the effects of the mobile app on EFL students' vocabulary learning, vocabulary retention, and on their perceptions of the app, several pedagogical implications emerged as follows.

First, the mobile app can be applied to assist vocabulary teaching and learning under the COVID-19, for at the special period, students' learning in classrooms is not

allowed or impossible in many countries around the world.

Second, the mobile app was beneficial in improving the students' vocabulary learning and retention more effectively than the paper-based wordlist, and also most of the Chinese EFL learners enjoyed using it. This indicates the possibility of re-judging the English vocabulary teaching practices for Chinese EFL learners. So, an alternative to learn or teach EFL vocabulary may be desirable. In turn, this would generate implications for EFL teachers and different stakeholders, such as educational directors and policy-makers. They should consider two points: replicating this study by a larger scale for checking the generalizability of current results and supporting the development of other English language skills, such as listening, grammar, and reading with well-designed mobile apps. For instance, English teachers can design listening comprehension activities well and add them into the mobile app for students to learn and practice anywhere anytime. As described in diary D21W8EG of the present study, this kind of learning method via the app was not only suitable for vocabulary development but also for the improvement of other English language skills.

Third, students could form their autonomous habit of learning vocabulary via the app. In a mobile technology era, it is not necessary for students to depend heavily on teachers like the traditional model of the past. Also, it is not sufficient for university students to learn vocabulary within a limited classroom time. As claimed by the researchers (Chumcharoensuk, 2013; Ko & Goranson, 2014; Schmitt, 1998a, 2000), vocabulary learning and retention are time-consuming in EFL settings, as the acquisition of vocabulary knowledge is both a continuous and incremental process. So the advantages of the mobile app can be fully exploited by learners to develop their vocabulary on their own. Nevertheless, teachers should conduct monitoring during

students' vocabulary learning via mobile apps. Some evidence for this was found in the present study. For example, St.7 in the interview said: "*...there are many temptations in the mobile phone, and it easily distracts me to other things for I am not a self-disciplined person...*". Also, another interviewee (St.11) suggested, "*...Adding a time alarm setting in the app, like reminding us to memorize words when every time is up...*". Similarly, one student described in diary D18W6EG "*...What I find the hardest thing to remember is not words, but easy to forget memorizing the words next time...*".

Lastly, the findings could have impacts on the layout, design and online/offline learning concening mobile apps. In the current study, the mobile app proved to be both a useful resource and to some extent frustrating, which is consistent with the findings of Makoe & Shandu (2018). It was a useful resource because it offered students convenient and easy access to the vocabulary learning contents with advantages as mentioned above. It was, however, frustrating for the students when the mobile phones hindered access to the contents, such as when there was no network. Therefore, app developers should consider developing apps that meet all the needs, both academic and technological, of the students.

5.3 Recommendations for Further Research

There are three recommendations for future research as follow.

Firstly, the present study was a preliminary attempt to improve Chinese EFL learners' vocabulary learning and retention in a local university. Therefore, to further validate the effectiveness of using a mobile app for EFL learners, a large-scale replication study is needed with an increase of the sample size from different grades and at various universities in China.

Secondly, future researchers should conduct a thorough needs analysis of their learners to establish individual differences before selecting vocabulary content and developing mobile apps. The present study revealed that different students from both groups had different feelings towards the same ten words in the same week. For instance, in the eighth week, one student of the experimental group in diary D19W8EG described: "*it was easy to learn and remember the words this week*." While in the same week, another student in diary D32W8EG wrote: "*I found it very difficult to learn and memorize the words this week*." Similarly, in the fifth week, one student of the control group in diary D53W5CG mentioned: "*the words this week were not complicated for me so that I could remember them quickly and clearly...* ". But in the same week, another student in diary D6W5CG wrote: " *the words had many meanings this week, even though I spent a longer time learning them, I still found it difficult to store them in my mind*." These difficulties may have had to do with the different amounts of vocabulary known to the students, as well as their English proficiency. Consequently, researchers need to choose words and design exercises in the apps at different levels of difficulty for students so that they will be able to learn vocabulary more effectively.

Thirdly, besides vocabulary learning, many further studies should be carried out concerning the impacts of mobile apps on other English language skills in EFL settings especially during the COVID-19. The fifth-generation mobile network (5G) arrived in our daily lives in 2019 with the strengths: reduced latency, high data rates, energy savings, increased system capacity, reduced costs, large-scale device connectivity, and it will become widespread from 2020 onwards. A report from the Ministry of Industry and Information Technology (MIIT) of China on October 31 of 2019 announced three important communications operators (China Telecom, China Mobile, China Unicom)

and 5G commercial packages. These 5G commercial packages were officially launched on November 1 in the whole of China, which means that China has now stepped into the era of 5G. As a result, research focusing on the impacts of 5G mobile technology on the teaching of English language skills will be urgently needed.

Finally, further research could be conducted through the iOS system-based mobile apps, for in the present study the mobile app was only operated for smartphones with the Andriod systems to learn vocabulary and then its widespread usage could be limited.

5.4 Summary of the Chapter

This chapter draws a conclusion to the current study. In the first section, the main results of the study were summarized. In the second section, the pedagogical implications gained from the study were presented. Finally, four recommendations were offered for future research.

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APPENDIX A

Top 80 High-frequency CET4 Words of the Corpus as Target Words

1. treat	21. illegal	41. casual	61. launch
2. abundant	22. economical	42. staff	62. reluctant
3. transfer	23. alter	43. prohibit	63. chill
4. chew	24. register	44. appeal	64. boast
5. objective	25. ensure	45. tackle	65. chase
6. intend	26. emit	46. reputation	66. switch
7. optional	27. distribute	47. slip	67. contrast
8. despite	28. strategy	48. contact	68 pitch
9. intense	29. influence	49. assignment	69. negotiation
10. expand	30. dim	50. entitle	70. drift
11. local	31. individual	51. illustrate	71. kit
12. acknowledge	32. insert	52. discipline	72. drain
13. behalf	33. discharge	53. characteristic	73. squeeze
14. generous	34. hint	54. criticise	74. collect
15. resolve	35. remark	55. exhaust	75. instal
16. automatic	36. efficient	56. assist	76. response
17. species	37. adequate	57. deceive	77. convey
18. involve	38. appropriate	58. overtake	78. commercial
19. estate	39. brand	59. consume	79. imitate
20. conduct	40. overall	60. legal	80. crack

APPENDIX B

The Informed Consent Form for the Experimental Group

You will participate in a research project to explore the effects of using a mobile application on CET4 vocabulary learning and retention. It will be conducted for a period of 8 weeks in the first semester of academic year 2019-2020. Your role in this study is to learn 80 CET 4 words via a mobile app independently by the five-time week schedule, and keep diaries. Besides, the relevant pretest, posttest, delayed-posttest will be conducted. Also, diaries will be collected weekly and the semi-structured interview will be performed at last. All information that you provide will be kept strictly confidential. I promise not to use your real name during my whole thesis. Once this study is completed, I will summarize my findings, which hopefully are helpful for your vocabulary learning, especially CET4 vocabulary learning. If you have any questions about this research project, please feel free to contact me at maxxjxnu@qq. com. If you agree to participate in this project, please sign below. Thank you for your cooperation.

Sincerely,

Researcher: Xingxing Ma, a Ph. D candidate in Suranaree University of Technology

Signed Participant: Date:

Signed Researcher: Date:

APPENDIX C

The Informed Consent Form for the Control Group

You will participate in a research project to explore the effects of using a paper-based wordlist on CET4 vocabulary learning and retention. It will be conducted for a period of 8 weeks in the first semester of academic year 2019-2020. Your role in this study is to learn 80 CET 4 words with the paper-based wordlist independently by the five-time week schedule, and keep diaries. Besides, the relevant pretest, posttest, delayed-posttest will be conducted. Also, diaries will be collected weekly. All information that you provide will be kept strictly confidential. I promise not to use your real name during my whole thesis. Once this study is completed, I will summarize my findings, which hopefully are helpful for your vocabulary learning, especially CET4 vocabulary learning. If you have any questions about this research project, please feel free to contact me at maxxjxnu@qq. com. If you agree to participate in this project, please sign below. Thank you for your cooperation.

Sincerely,

Researcher: Xingxing Ma, a Ph. D candidate in Suranaree University of Technology

Signed Participant: Date:

Signed Researcher: Date:

APPENDIX D

Sample of the First Wordlist for the Control Group

Week 2 (10 words)

1. involve / ɪnˈvɒlv / v. 包含; 使参与，牵涉; 围绕， 缠绕; 使专心于	2. discharge / dɪsˈtʃɑːdʒ / n. 发射；释放；解雇；放电 v. 卸掉负担；发射；放电 vt. 卸（货）；使爆炸；履行；解雇
3. abundant /əˈbʌndənt/ adj. 丰富的；大量的	4. collect / kəˈlekt / v. 收集；领取；聚集；募捐 adj. 由对方付费的 n. （宗）短祷文
5. expand /ɪkˈspænd/ v. 膨胀；扩大 vt. 详细展开	6. influence /ˈɪnfluəns / n. 影响; 势力; 有影响的人（或事物） v. 影响
7. insert /ɪnˈsɜːt/ vt. 插入；嵌入 n. 插入物；插页	8. prohibit /prəˈhɪbɪt/ v. 禁止
9. squeeze / skwiːz / v. 挤进，塞进；用力挤 压榨取；减少，压缩 n. 榨；压榨；挤，塞	10. commercial /kəˈmɜːʃl/ adj. 商业性的，贸易的 n. 商业广告

APPENDIX E

Vocabulary Size Test (Nation & Beglar, 2007)

An excerpt of ten words in VST (Nation & Beglar, 2007) is presented. The complete test can be reached at http:// www. lextutor. ca/. Instructions: choose the letter a-d with the closest meaning to the word in bold in the sentence.

1. "see: They **saw** it. ( )

   a. cut b. waited for c. looked at d. started"

2. "time: They have a lot of **time**. ( )

   a. money b. food c. hours d. friends"

3. "period: It was a difficult **period**. ( )

   a. question b. time c. thing to do d. book"

4. "figure: Is this the right **figure**? ( )

   a. answer b. place c. time d. number"

5. "poor: We are **poor**. ( )

   a. have no money b. feel happy

   c. are very interested d. do not like to work hard"

6. "drive: He **drives** fast. ( )

   a. swims b. learns c. throws balls d. uses a car"

7. "jump: She tried to **jump**. ( )

   a. lie on top of the water b. get off the ground suddenly

   c. stop the car at the edge of the road d. move very fast"

8. “shoe: Where is your **shoe**? ( )

a. the person who looks after you

b. the thing you keep your money in

c. the thing you use for writing

d. the thing you wear on your foot”

9. “standard: Her **standard**s are very high. ( )

a. the bits at the back under her shoes

b. the marks she gets in school

c. the money she asks for

d. the levels she reaches in everything”

10. “basis: This was used as the **basis**. ( )

a. answer

b. place to take a rest

c. next step

d. main part”

APPENDIX F

Knowledge Scale Test of 80 Words

Choose the most suitable one (I-V) for you to fill in the bracket, and do as told in the bracket if you choose one from III to V. One example is shown how to do it. **I**. I don't remember having seen the word before. **II**. I have seen this word before, but I don't know what it means. **III**. I have seen this word before, and I think it means _____. (synonym or translation) **IV**. I know this word. It means _____. (synonym or translation) **V**. I can use this word in a sentence: _____. (Make a sentence.)

(If you do this section, please also do Section IV

1 treat ( )	21 illegal ( )	41 casual ( )	61 launch ( )
2 abundant( )	22 economical ( )	42 staff ( )	62 reluctant ( )
3 transfer ( )	23 alter ( )	43 prohibit ( )	63 chill ( )
4 chew ( )	24 register ( )	44 appeal ( )	64 boast ( )
5 objective ( )	25 ensure ( )	45 tackle ( )	65 chase ( )
6 intend ( )	26 emit ( )	46 reputation ( )	66 switch ( )
7 optional ( )	27 distribute ( )	47 slip ( )	67 contrast ( )
8 despite ( )	28 strategy ( )	48 contact ( )	68 pitch ( )
9 intense ( )	29 influence ( )	49 assignment ( )	69 negotiation ( )
10 expand ( )	30 dim ( )	50 entitle ( )	70 drift ( )
11 local ( )	31 individual ( )	51 illustrate ( )	71 kit ( )
12 acknowledge ( )	32 insert ( )	52 discipline ( )	72 drain ( )
13 behalf ( )	33 discharge ( )	53 characteristic( )	73 squeeze ( )
14 generous ( )	34 hint ( )	54 criticise ( )	74 collect ( )
15 resolve ( )	35 remark ( )	55 exhaust ( )	75 install ( )
16 automatic ( )	36 efficient ( )	56 assist ( )	76 response ( )
17 species ( )	37 adequate ( )	57 deceive ( )	77 convey ( )
18 involve ( )	38 appropriate ( )	58 overtake ( )	78 commercial ( )
19 estate ( )	39 brand ( )	59 consume ( )	79 imitate ( )
20 conduct ( )	40 overall ( )	60 legal ( )	80 crack ( )

APPENDIX G

Checking Item-Objective Congruence (IOC) of Draft Questionnaire

Items	Expert A	Expert B	Expert C	Agreement
1. The vocabulary learning app is easy to use.	1	1	1	√
2. Learning vocabulary via the app is convenient since I can choose the materials	1	0	1	×
3. The app makes vocabulary learning easier for me compared with wordlist.	1	1	1	√
4. It is a good method to learn vocabulary via the app.	1	1	1	√
5. I like the app more than the method I used.	1	1	0	×
6. The vocabulary learning app motivates me to learn new words.	1	1	1	√
7. The app is useful for me to learn vocabulary.	1	1	1	√
8. The vocabulary learning can help me learn more.	1	0	0	×
9. The immediate feedback in the app can push me to monitor and adjust my vocabulary learning.	1	1	1	√
10. The Retrieval Session in the app enables me to review and remember the vocabulary very well.	1	1	1	√
11. The app makes learn vocabulary more convenient outside classroom.	1	1	1	√
12. I can learn the words easier based on the clues of the images and example sentences in the app.	1	1	1	√

Items	Expert A	Expert B	Expert C	Agreement
13. The contexts of the example facilitate words' knowledge in my mind.	0	0	1	×
14. The vocabulary learned via the app is not easily forgotten.	1	1	1	√
15. The contexts of the example sentences helps me learn how to use the words appropriately.	1	1	1	√
16. In the future I will continue to use the app to learn vocabulary.	1	1	1	√
Total score	15	13	14	

Notes: 1. "1" for the item is congruent with objective; 2. "0" for the uncertainty of the item; 3. "-1" for the item is not congruent with objective;

2. Result of IOC:

IOC = ÓR/ N

ÓR=15+14+13=42 (Scores from experts)

N=2 (Number of experts) IOC=42/3=14

Number of Items : 16

IOC index: 14/16=0.875 > 0.5 = valid

PPENDIX H

(English Version)

Questionnaire of Students' Perceptions of the App

Using the questionnaire is for collecting information about your perceptions on the app. The questionnaire is not a test sheet with "right" or "wrong" answers. Also, the questionnaire you responded to will only be for this study and treated carefully. Your nice cooperation will be thanked much.

Part 1 Personal Information

Instructions: Please read each of the following items carefully and fill in the blanks or mark (√) the responses which best describe your situation.

1. Gender：☐ male ☐ female

2. Age：____Length of learning English:_____English scores in NCEE:_____

3. Have you ever used any mobile application to learn English? Yes or no? If yes, what is it? And for which English skills (listening, speaking, reading, writing and translation)

   _____

4. Have you ever used any mobile application to learn English vocabulary? Yes or no? If yes, what was it?

   _____

Part 2 Perceptions on using the app

Instructions: Please read each statement carefully and choose (√) the responses which best describe your perceptions on using the app.

1= Strongly Disagree; 2= Disagree; 3= Not sure; 4= Agree; 5= Strongly Agree

Items	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
1. The vocabulary learning app is easy to use.	1	2	3	4	5
2. Learning vocabulary via the app is convenient, for I can choose place and time to learn new words.	1	2	3	4	5
3. The app makes vocabulary learning easier for me compared with wordlist.	1	2	3	4	5
4. It is a good method to learn vocabulary via the app.	1	2	3	4	5
5. I prefer the app to traditional wordlist for learning vocabulary.	1	2	3	4	5
6. The vocabulary learning app motivates me to learn new words.	1	2	3	4	5
7. The app is useful for me to learn vocabulary.	1	2	3	4	5
8. The Learning Sections in the app help me learn vocabulary more effectively.	1	2	3	4	5
9. The immediate feedback in the app can push me to monitor and adjust my vocabulary learning.	1	2	3	4	5

Items	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
10. The Retrieval sections ion in the app enable me to review and remember the vocabulary well.	1	2	3	4	5
11. The app makes vocabulary learning more convenient outside classroom.	1	2	3	4	5
12. I can learn the words easier based on the pictures and example sentences in the app.	1	2	3	4	5
13. The example sentences can consolidate words in my mind.	1	2	3	4	5
14. The vocabulary learned via the app is not easily forgotten.	1	2	3	4	5
15. The example sentences help me learn how to use the words appropriately.	1	2	3	4	5
16. In the future, I will continue to use the app to learn vocabulary.	1	2	3	4	5

APPENDIX H

(Chinese Version)

Questionnaire of Students' Perceptions of the App

一份关于使用 CET4 words 学习应用软件后的问卷

这份问卷不是测试，所以你的选择没有对错之分。非常感谢各位同学的配合。

第一部分：个人信息，根据自己的信息打勾或填写

1. 性别：男（　　），女（　　）
2. 年龄：_____ 学习英语的年限_____ 高考中的英语分数:_____
3. 你以前用过手机应用软件（mobile App）学英语吗？用过或没用过？如果用过，那款应用软件叫什么名字？你用它学过英语的哪项技能呢？（听/说/读/写/翻译或是_____）

   _____

4. 你以有使用过学习英语词汇的应用软件吗？有或没有？如果有使用过，请写出它们的名字。

   _____

第二部分 使用这款四级词汇学习应用软件后的感觉

仔细阅读每一项陈述，根据自身的使用情况或感受在相应数字上打勾做出选择：1, 非常不同意；2，不同意；3，不太确定；4，同意；5，非常同意

陈述	1，非常不同意	2，不同意	3，不太确定	4，同意	5，非常同意
1. 这款应用软件用起来很简单.	1	2	3	4	5
2. 我觉得用这款应用软件学单词很自由.	1	2	3	4	5
3. 这软件让我学单词很轻松。	1	2	3	4	5
4. 用这款应用软件学单词对我来说是种创新的方式。	1	2	3	4	5
5. 相比以前词汇表学单词，我更喜欢用这款应用学单词。	1	2	3	4	5
6. 这软件激发我去学新单词。	1	2	3	4	5
7. 这应用软件对我学单词很有用。	1	2	3	4	5
8. 这款应用软件里的与单词相关学习内容能帮我更有效地学习单词。	1	2	3	4	5
9. 这应用软件里的及时反馈能促使我监控以及调节我学习单词的过程。	1	2	3	4	5
10. 这应用上的复习练习能让我很好地复习单词并记住单词。	1	2	3	4	5
11. 在课外，这应用让我学单词更加方便。	1	2	3	4	5
12. 根据应用里的图片和例句，我学起单词来更加容易。	1	2	3	4	5
13. 这应用里的例句能帮助我在脑海里巩固单词。	1	2	3	4	5
14. 通过应用软件学过的单词不容易忘记。	1	2	3	4	5
15. 这应用里的例句能帮我学会如何恰当地使用单词。	1	2	3	4	5
16. 将来我会继续用这款应用学习单词。	1	2	3	4	5

APPENDIX I

Checking IOC of the Interview Questions

Questions	Expert A	Expert B	Expert C	Agreement
1. Do you enjoy learning vocabulary via the app? Yes or no? And why?	1	1	1	√
2. Is the app helpful for your vocabulary learning? Yes or no? And why?	1	1	1	√
3. Is the app interesting to you? Yes or no? And why?	1	1	1	√
4. Comparing the traditional word list-based learning approach with the app-assisted vocabulary learning, which one do you prefer? And why?	1	1	1	√
5. Is it convenient for you to learn vocabulary via the app? Yes or no? And why?	1	1	1	√
6. Do you think that the pictures or example sentences are helpful for you to learn vocabulary? Yes or no? And Why?	1	1	1	√
7. Do you believe that the vocabulary exercises can facilitate your retention of vocabulary? And why?	1	1	1	√
8. Is the feedback provided by the app useful for you to adjust your vocabulary learning? Yes or no? And why?	0	1	0	×
9. What else would you like to say about the app-assisted vocabulary learning in the present study?	1	1	1	√
10. What do you think of the mobile app in general?	1	0	0	×
11. What don't you like about the mobile app?	1	1	1	√
Total score	**10**	**10**	**9**	

Notes: 1. “1” for the item is congruent with the objective; 2. “0” for the uncertainty of the item; 3. “-1” for an item which is not congruent with the objective;

2. Result of IOC index:

IOC = ÓR/ N

ÓR=10+10=20 (Scores from experts)

N=2 (Number of experts)

IOC=29/3=9. 67

Number of Items: 11

IOC index: 9. 67/11=0. 88 > 0. 5 = valid

APPENDIX J

(English Version)

The Interview Questions on Perceptions of the App

1. Do you enjoy learning vocabulary via the App? Yes or no? And why?
2. Is the app helpful for your vocabulary learning? If yes, in what ways? If no, why not?
3. Is the app interesting? If yes, in what ways?
4. Comparing the traditional word list-based learning approach with the App-assisted vocabulary learning, which one do you prefer? And why?
5. Please describe your opinions of the App?
6. Is it convenient for you to learn vocabulary via the App? If yes, in what ways?
7. What do you think of the pictures or example sentences in the App?
8. What do you think of the vocabulary exercises in the App?
9. What do you think of the prompt feedback in the App?
10. What else would you like to say about the the App-assisted vocabulary learning in the present study?
11. What do/don't you like about the mobile App? Please describe it.

APPENDIX J

(Chinese Version)

The Interview Questions on Perceptions of the App

关于使用这款应用软件感觉的访谈问题

1. 你喜欢用四级词汇 App 学单词吗？喜欢或不喜欢？为什么？

2. 四级词汇 App 对你学单词有帮助吗？如果有，哪些方面有？如果没有，为什么？

3. 你觉得四级词汇 App 有趣吗？如果有，哪些方面有？如果没有，为什么？

4. 用四级词汇 App 学单词与传统的词汇表学单词相比，你更喜欢哪种学单词的方式？为什么？

5. 请描述一下你对四级词汇 App 的看法。

6. 你用四级词汇 App 学单词方便吗？如果方便，哪些方面方便？

7. 你觉得四级词汇 App 里的图片和例句怎么样？

8. 你觉得四级词汇 App 里的词汇练习怎么样？

9. 你觉得四级词汇 App 里提供的及时反馈怎么样？

10. 关于四级词汇 App，你还有什么想说的吗？

11. 关于四级词汇 App，有哪些你喜欢或不喜欢的地方？请写下来。

APPENDIX K

Criterion for Determining a Representative Interview Sample

(AMHSA, 2010)

Participants	Minimum Interviews	Participants	Minimum Interviews	Participants	Minimum Interviews
0-9	ALL	86-99	22	339-369	53
10-12	9	100-149	24	370-475	58
13-17	11	150-199	26	476-550	65
18-24	13	200-220	30	551-600	70
25-30	15	221-240	35	601-700	80
31-44	17	241-299	37	701-800	86
45-64	19	300-320	42	801-900	90
65-85	21	321-338	47	901-1000	100

APPENDIX L

Pilot Study

1 Participants

According to availability and convenience, two intact classes with 116 non-English major newcomers were selected from Anshun University of China for taking part in this pilot study in the first semester in the 2018 academic year. One class with 56 students was the experiment group, and the other one with 60 students was the control group. The demographic information of the two groups was shown in Table1. 1 below.

Table 1. 1 The demographic information of the two groups in the pilot study

	Number	Average age	Gender	Length of Learning English	English Proficiency	Sig.
Experiment Group	56	19	Male=26 Female=30	7-9 years	Mean=88. 68	. 351
Control Group	60	18	Male=33 Female=27	8-9 years	Mean=91. 82	

Significant level p<. 05

As seen in Table 1. 1 above, the two groups had similar features in number, age, the proportion of male/female, and the length of English learning. Their English proficiency was from the English scores of the National College Entrance Exam (NCEE). NCEE is held yearly for screening out students for universities all over China, which is well known as being high reliability and validity all the time. With an independent-samples t-test, few differences in English proficiency between them were found for p=0. 351>0. 05.

2 Research Questions

1. What are the effects of using the app on EFL students' vocabulary learning achievement?

2. What are the effects of employing the app on EFL students' vocabulary retention?

3. What are the EFL learners' perceptions of vocabulary learning via the app?

3 Research Instruments

The same instruments used in the pilot study as those in the main study are not repeated because the details of the instruments have been presented in section 3. 3 of chapter three. Being slightly different from the the questionnaire and interview questions in the main study, the perception questionnaire and the list of interview questions for the pilot study were shown in Appendix M and Appendix N, respectively.

4 Experiment and Data Collection

The pilot study started in September of 2018 academic year. On week 1, the Vocabulary Size Test (Appendix E) and the knowledge scale of 80 target words (Appendix F) were used as pretests to examine whether a big difference existed on VST or VKS.

Firstly, with the analysis of independent-samples t-test, as shown in Table 1. 2 below, few differences (P=0. 788> 0. 05) on their vocabulary size between two groups were revealed. Next, based on two groups' mean from Table 1. 2, their vocabulary size was about 2,300 words, which were far away from the requirement of 4,500 words for CET4. This means that they have more CET4 words to learn in order to pass CET4. The 80 words in the treatment are the high frequency in CET4, whose mastery would be beneficial for their passing CET4. So they were suitable for the experiment.

Table 1. 2 Comparison of the vocabulary size between two groups

	Group	N	Mean	S. D.	Sig.
Vocabulary size test	EG	56	2335. 00	454. 539	. 788
	CG	60	2375. 00	477. 96	

EG: Experiment Group; CG: Control Group; (Significant level p<. 05)

Furthermore, as shown in Table 1. 3 below, there was no significant difference (P=0. 119> 0. 05) on their knowledge of the target words between the two groups in the pretest with independent-samples t-test. Besides, according to the means of 80 target words for the two groups in the pretest (M of EG=153. 11; M of CG=160. 20), they were worth learning for the students, because they were mostly unfamiliar or unknown to the students.

Table 1. 3 Comparison of the means of the words' knowledge between the two groups

	Group	N	Mean	S. D.	Sig.
Pretest	EG	56	153. 11	26. 700	. 119
	CG	75	160. 20	24. 057	

EG: Experiment Group; CG: Control Group. (Significant level p<. 05)

After finding that both groups had similar vocabulary sizes and were almost unfamiliar with the target words above, in week 2, the researcher began to provide the experiment group with a tutorial on how to download and use the mobile app containing the 80 target words (see 3. 3. 2). The control group was offered a paper-based list of the same words (Appendix D) by the researcher. Both of them learned and retained the target words independently outside the classroom in the following four weeks.

In week 6, both groups took the knowledge scale as a post-test. Next, the experiment group filled in the questionnaire (Appendix M). Then, according to

AMHSA (2010) (Appendix K), the number of 19 students in the experiment group was decided. The 19 students whose ID numbers were odd (1,3,5,7.... ending with 37) were selected as interviewees to answer the interview questions (Appendix N) in the same week. Moreover, the data from the interview was collected with the help of a tape recorder and notes taking. In week 11, two groups took the knowledge scale as a delayed-posttest.

5 Results of the Pilot Study

In this section, two parts are included. The first part presents the results obtained from the test. The second part reports the findings from the questionnaire and the semi-structured interview.

5.1 Comparison between the Scores from the Pre-tests and Post-tests

Table 1. 4 Comparison of the two tests' scores between the two groups

Group	Tests	Mean	S.D.	N	Sig.
EG	Pretest	153.11	24.057	56	.000
	Post-test	289.09	45.893	56	
CG	Pretest	160.20	26.700	60	.000
	Post-test	248.44	50.939	60	

EG: Experiment Group; CG: Control Group. (Significant level p<. 05)

As shown in Table 1. 4 above, with descriptive analysis, the means of the pretest and posttest for the experiment group and control group were 153. 11 and 289. 09, respectively. With the paired-samples t-test of the experiment group, a huge difference on the scores above was seen (p=0. 000<0. 05). For the control group, between the score of pretest and that of post-test, a large difference was disclosed (p= 0. 000 < 0. 05), and the mean of the pretest differed obviously from that of the post-test (M of pretest=160. 20; M of posttest=248. 44). The mean of the posttest (M of EG=289. 09; M of CG=248.44) was higher than that of the pretest (M of EG=153. 11; M of CG=160.

20) . This signified that both groups were enhanced noticeably on target words' knowledge after treatment.

Table 1. 5 Comparison of the post-test scores between the two groups

	Group	N	Mean	S.D.	Sig.
Post-test	EG	56	289.09	45.893	.000
	CG	60	248.44	50.939	

EG: Experiment Group; CG: Control Group. (Significant level p<. 05)

As seen in Table 1. 5 above, by applying independent-samples t-test of the posttest scores between two groups, a significant difference was demonstrated (p= 0. 00< 0. 05), and the mean of EG (M of EG=289. 09) was much larger than that of CG (M of CG=248. 44). It showed that students in the experiment group achieved much more improvement on the words' learning by using the app compared with those from the control group. This illustrated that using the app had a significantly positive effect on improving learners' achievements in vocabulary learning, which was the answer to the first research question.

5. 2 Comparison of the scores from the posttests and delayed-posttests

Table 1. 6 Comparison between delayed-posttests and posttests from two groups

Group	Tests	Mean	S.D.	N	Sig.
EG	Delayed-Posttest	274.59	47.708	56	.104
	Posttest	289.09	45.893	56	
CG	Delayed-Posttest	202.73	36.926	60	.000
	Posttest	248.44	50.939	60	

EG: Experiment Group; CG: Control Group. (Significant level p<. 05)

As seen in Table 1. 6 above, the means of the delayed-posttests from two groups were 274. 59 and 202. 73, respectively, which both decreased compared with those of

the posttests (M of EG=289. 09; M of CG=248. 44). Based on the means of delayed-posttests, the retention of the words for the control group decreased very much, while the retention of the words for the experiment group decreased little.

By paired-samples t-test for the experiment group, there was no significant difference between the delayed-posttest and posttest scores because the p-value was 0. 104, which was higher than 0. 05 (p=0. 104>0. 05). Nevertheless, with paired-samples t-test for the control group, a significant difference was found between the delayed-posttest and posttest scores, because the p-value was lower than 0. 05 (p= 0. 000 < 0. 05).

Table 1. 7 Comparison of the delayed post-test scores between the two groups

	Group	**N**	**Mean**	**S. D.**	**Sig.**
Delayed Post-test	EG	56	274. 59	47. 708	.000
	CG	60	202. 73	36. 926	

EG: Experiment Group; CG: Control Group. (Significant level p<. 05)

As demonstrated in Table 1. 7 above, by applying an independent-samples t-test for the delayed post-test scores between the two groups, a large difference was found (p=0. 000<0. 05). Besides, it could be seen that the mean of the experiment group (M=274. 59) in the delayed post-test was much higher than that of the control group (M=202. 73).

The students' retention of the words from both groups declined after four weeks. However, the students from the experiment group employing the app could remember more words than those from the control group. So the answer to the second research question could be that using the app had a significantly positive effect on helping learners retain more words.

5.3 Results from the Student' Questionnaires

Table 1. 8 Responses from the questionnaire with percentages (N=56)

Items	1. Strongly Disagree	2. Disagree	3. Not sure	4. Agree	5. Strongly Agree
1. The vocabulary learning app is easy to use.	1.8%	1.8%	3.6%	71.4%	21.4%
2. Learning vocabulary via the app is convenient for I can choose place and time.	0%	0%	10.7%	60.7%	28.6%
3. It is easier for me to learn vocabulary via the app.	1.8%	3.6%	21.4%	55.4%	17.9%
4. It is a good method to learn vocabulary via the app.	0%	7.1%	12.5%	53.6%	26.8%
5. I prefer the app to the traditional wordlist for learning vocabulary.	1.8%	8.9%	19.6%	41.1%	28.6%
6. The vocabulary learning app motivates me to learn new words.	1.8%	1.8%	30.4%	53.6%	12.5%
7. The app is useful for me to learn vocabulary.	0%	3.6%	17.9%	55.4%	23.2%
8. The Learning Session in the app helps me learn vocabulary more effectively.	0%	3.6%	14.3%	51.8%	30.4%
9. The immediate feedback in the app can push me to monitor and adjust my vocabulary learning.	1.8%	7.1%	10.7%	57.1%	23.2%
10. The Retrieval Session in the app enables me to review and remember the vocabulary very well.	0%	3.6%	28.6%	46.4%	21.4%
11. The app makes vocabulary learning more convenient outside classroom.	0%	1.8%	8.9%	55.4%	33.9%
12. I can learn the words easier based on the contexts of images and example sentences in the app.	0%	3.6%	14.3%	58.9%	23.2%
13. The contexts of the example sentences in the app can consolidate knowledge of the words.	0%	7.1%	35.7%	41.1%	16.1%
14. The vocabulary learned via the app is not easily forgotten.	1.8%	7.1%	41.1%	41.1%	8.9%
15. The contexts of example sentences help me learn how to use the words appropriately.	0%	8.9%	39.3%	42.9%	8.9%

Items	1. Strongly Disagree	2. Disagree	3. Not sure	4. Agree	5. Strongly Agree
16. In the future, I will continue to use the app to learn vocabulary.	0%	0%	17.9%	53.6%	28.6%

Based on Chang et al. (2012) and Davis (1989), the items of the questionnaire concerning technology-assisted language learning can be summarized into five categories containing continuance intention to use, attitude towards using, perceived ease of use, perceived convenience, and perceived usefulness. So all items from the questionnaire are separated into the five categories. The separation result of the items is shown in Table 1. 9 below.

Table 1. 9 Items of the questionnaire separated into categories

	Perceived convenience	Perceived ease of use	Perceived usefulness	Attitude towards using	Continued intention to use
Items	2, 11	1,3,12	6,7,8,9,10,13,14,15	4,5	16

Firstly, according to the responses of items 2 and 11 in Table 1. 9 above, the number of the students who perceive the mobile app as convenient to use accounts for 89. 3% of total students in the experiment group. Next, from the responses of items 1, 3, and 12, it is found that 82.7% of the students consider the app makes their vocabulary learning easy. Thirdly, in terms of the responses on items 6,7,8,9,10,13,14 and 15, 65. 4% of the students refer to the app as being useful for vocabulary learning. Fourthly, based on their responses of items 4 and 5, it is shown that 90. 1% of the students hold positive attitudes towards the usage of the app. Finally, 82. 2% of the students express their willingness to continuously use the app in the future from the responses of item 16.

5.4 Results from the Student' Interviews

Based on Dörnyei (2007), thematic analysis was used to analyze the data from the interviews in the pilot study. In order to form the themes from data, the responses of the interviewees were used as evidence. Each interviewee was numbered according to the time of the order of being interviewed. For instance, St. 1 stood for the first student to be interviewed. Through data analysis, four categories were found and then formed into one theme. The theme, categories, and evidence were shown in Table 1. 10 below.

Table 1. 10 Theme and categories found from the interviews

Theme: perception	**Evidence (interviewees' responses)**
Category 1: feel helpful	**St. 19**, …the three kinds of exercises help me remember the learned words.
	St. 11,…it only focuses on CET4 words, so it helps me a lot with the preparation of CET4.
	St. 8,. . the immediate feedback makes me realize shortcoming and pay more attention to the words.
Category 2: feel interesting	**St. 1**,…the pictures and example sentences are very interesting to arouse my interest in learning words.
	St. 6,…it is interesting to learn and review vocabulary by the app with flexibility.
Category3: feel convenient	**St. 5**,…there is no limitation of time and space for learning words via the app, so it is convenient.
	St. 9,…as long as the mobile phone is on me, I can use the app to learn vocabulary, so convenient.
Category 4: feel no pressure	**St. 13**,…when I take the textbook and look at the word list, I feel so stressful for there are lots of words to learn and recite. The app makes me no pressure and happy to learn words.
	St. 16,…learning 10 words one time via the app brings me fun just like to complete a mission. And the contents are diversified that I can not feel depressed.

According to the interviewees' responses, four categories were formed and a theme could be refined from them. Firstly, as seen in Table 1. 10, students considered the app as being helpful mainly for the contents' design and the target words. Next, the

app was perceived as being interesting because of the presentation ways of the words and the app itself. Thirdly, most of the students thought the app as being convenient, because it is much more convenient to carry a mobile phone than to carry a textbook, and they can use it anytime anywhere to learn words through the app. Fourthly, the students referred to the app as a method to learn vocabulary without pressure, because the diversified contents and the number of words to be learned make them feel fun, especially compared with the traditional long word list for them to learn. Finally, based on the four categories above, one theme, perception of the app, could be refined. To conclude, students had good perceptions of vocabulary learning via the mobile app.

APPENDIX M

Questionnaire of Students' Perceptions for Pilot Study

The purpose of the questionnaire is for understanding your perceptions on using the app. So your responses would not be judged "right" or "wrong". Besides. What you responded is only applied for this study and used cautionsly with confidentiality. Many thanks for your nice cooperation.

Part 1 Personal Information

Instructions: Please read each of the following items carefully and fill in the blanks or mark (√) the responses which best describe your situation.

1. Gender： □ male □female

2. Age：____Length of learning English:_____English scores in NCEE:_____

3. Have you ever used any mobile application to learn English? Yes or no? If yes, what was it ? And for what English

skills (listening, speaking, reading, writing and translation)

_____

4. Have you ever used any mobile application to learn English vocabulary? Yes or no? If yes, what was it?

_____

Part 2 Perceptions on using the app

Instructions: Please read each statement carefully and choose (√) the responses which best describe your perceptions on using the app.

1= Strongly Disagree; 2= Disagree; 3= Not sure; 4= Agree; 5= Strongly Agree

Items	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
1. The vocabulary learning app is easy to use.	1	2	3	4	5
2. Learning vocabulary via the app is convenient for I can choose place and time to learn new words.	1	2	3	4	5
3. The app makes vocabulary learning easier for me compared with wordlist.	1	2	3	4	5
4. It is a good method to learn vocabulary via the app.	1	2	3	4	5
5. I prefer the app to traditional wordlist for learning vocabulary.	1	2	3	4	5
6. The vocabulary learning app motivates me to learn new words.	1	2	3	4	5
7. The app is useful for me to learn vocabulary.	1	2	3	4	5
8. The Learning Session in the app helps me learn vocabulary more effectively.	1	2	3	4	5
9. The immediate feedback in the app can push me to monitor and adjust my vocabulary learning.	1	2	3	4	5
10. The Retrieval Session in the app enables me to review and remember the vocabulary very well.	1	2	3	4	5
11. The app makes learn vocabulary more convenient outside classroom.	1	2	3	4	5
12. I can learn the words easier based on the clues of images and example sentences in the app.	1	2	3	4	5
13. The example sentences can consolidate words in my mind.	1	2	3	4	5
14. The vocabulary learned via the app is not easily forgotten.	1	2	3	4	5
15. The contexts of example sentences help me learn how to use the words appropriately.	1	2	3	4	5
16. In the future, I will continue to use the app to learn vocabulary.	1	2	3	4	5

APPENDIX N

The Interview Questions for Pilot Study

1. Did you enjoy learning vocabulary via the App? Yes or no? And why?
2. Is the app helpful for your vocabulary learning? If yes, in what ways? If no, why not?
3. Is the app interesting? If yes, in what ways?
4. Comparing the traditional word list-based learning approach with the App-assisted vocabulary learning, which one do you prefer? And why?
5. Is it convenient for you to learn vocabulary via the app? Yes or no? and why?
6. Do you think that the pictures or example sentences are helpful for you to learn vocabulary? Yes or no? And Why?
7. Do you believe that the vocabulary exercises can facilitate your retention of vocabulary? And why?
8. Is the feedback provided by the app useful for you to adjust your vocabulary learning? Yes or no? and why?
9. What else would you like to say about the the app-assisted vocabulary learning in the present study?
10. What do/don't you like about the mobile App? Please explain.

APPENDIX O

A Sample Interview Script

Interviewer: Ma Xingxing

Interviewee: St. 1

Date: December 27, 2019

Time: 19:05 P. M.

Place: Classroom No. 1007 at Anshun University of China

Me: Good evening.

St. 1: Good evening, Teacher Ma.

Me: Please take a seat.

St. 1: Thank you.

Me: In the following, I will ask you several questions concerning your perception, or anything related to your words' learning with the mobile App.

St. 1: OK, Teacher Ma, go ahead.

Me: **Do you enjoy learning vocabulary via the App?**

St. 1: Um. . . yes, I like using the App to learn vocabulary.

Me: Why?

St. 1: Because there are various and interesting contents in the App, and it is convenient to learn the words via the App.

Me: OK, I see. **Do you think the App helpful for your vocabulary learning or not?**

St. 1: Yes, it helps a lot. When I can not read the words, I would listen to the audios many times, I also read after the audios until I feel I could pronounce them correctly. And. . .

Me: **Do you feel the App interesting or not?**

St. 1: Yes, I think the App is very interesting.

Me: **Then, what aspects make you feel the App interesting?**

St. 1: Many interesting pictures and sentences arouse my interest in learning vocabulary.

Me: **Comparing the traditional word list-based learning approach with App-assisted vocabulary learning, which one do you prefer?**

St. 1: Of course, it is no doubt that I prefer the App to learn vocabulary. The traditional wordlist is boring, and the rote vocabulary learning makes me feel like a repetition machine. However, the App is different. I feel using the App to learn words could practice my listening, speaking, reading, writing skills. Also, it is much lighter to carry a smartphone than a heavy textbook to learn vocabulary. . .

Me: **Can you describe your opinions about the App?**

St. 1: Um. . . as I mentioned, the App is good, helpful, and interesting for me to learn and review words. Also, it mainly focuses on CET4 vocabulary, so it will be beneficial for making me prepare well for CET4 next year. . .

Me: **Is it convenient for you to learn vocabulary via the App?**

St. 1: Yes, it is quite convenient. Let me take an example. During the military training, all courses stopped, so I think all courses study would be suspended. Nevertheless, the task of CET4 vocabulary learning is going on thanks to the App, for it is convenient to learn the words at any corner anytime.

Me: **What do you think of the pictures or example sentences in the App?**

St. 1: I think the pictures are interesting, and make me understand the words quickly. Also the example sentences can make me know how to use the words appropriately. When I took the Target Words Knowledge Test, some pictures could make recall the meanings of the words. . .

Me: **What do you think of the vocabulary exercises in the App?**

St. 1: The exercises of the App could strengthen my memory of the words. You know, when I almost forget the meaning or the spelling of the words, doing the exercises can push me to squeeze my memory to recall the meanings or forms of the words. Even I failed to recall the words or made wrong choices about the exercise, I do not worry much. Because the link could make me relearn them in the learning sections, my memory of the words would be consolidated again. . .

Me: **What do you think of the prompt feedback in the App?**

St. 1: The prompt feedback is really helpful, for it can tell me whether I am wrong or right on my doing the exercises in time. If my responses are wrong, the link would make me learn the words again in the learning sections of the App. Of course, I will reflect on why I made wrong choices, and hopefully, I would not make similar mistakes again. . .

Me: **What else would you like to say about the App-assisted vocabulary learning in the present study?**

St. 1: I think it is useful, easy, and convenient to use the App for learning and reviewing CET4 words. I like it very much. Besides, we only have to learn 10 words at a time, so we do not feel stressful to learn the words.

Me: **What do/don't you like about the mobile App? Please explain.** Teacher Ma, can I say so far so good? Of course, if the App contains 4,500 CET4 words, it would be wonderful to persist in using it to prepare for CET4 in the future.

Me: Many thanks for your responses and precious time. Thank you again. This pen is a gift as my appreciation for your cooperation. See you around.

St. 1: See you, Teacher Ma.

APPENDIX P

The Representative Diaries concerning the Categories of Feelings about the App from the Experimental Group

1 Preferable

-in memorizing words

D42W2EG: "... I prefer this app to learn CET4 words. Hopefully, it can help my English learning in the long run... "

D55W2EG:" ... In the process of memorizing words, I feel very easy. Memorizing words with this app is very happy and exciting. I have a deep memory of learned words. Now remembering words is not as painful as before. So I prefer memorizing words via the app... "

D9W9EG:" ... After learning the words for eight weeks, I think I have learned a lot. Using this app to learn words does not make me feel tired, and I remember them firmly, so I prefer this app... "

D18W9EG:" ... I have been using this application for almost three months. I feel used to it and prefer using it to learn words... "

2 Convenient

-in time and place

D37W3EG:" ... During the National Day of China, all paper-based course study stopped for well all go out for fun. But I can learn words with the app when I am on the way... "

D39W3EG:" ... as long as the smartphone is on me, I can learn and review words via the app anytime, anywhere... "

D29W4EG:" ... during the military, I can use breaking time to recite vocabulary via the app. Also, it is convenient to recite words while I am having meals for saving time... "

D52W7EG:" ... it is getting colder, but I can still learn vocabulary via the app without leaving my warm bed... "

3 Effective

-in memory of words

D27W2EG:" . . . I feel it is very effective in reciting the words with the app, making me think that reciting words is not so difficult as before, and remembering ten words a week is easy to complete. . . "

D31W2EG:" . . . Words are memorized repeatedly, which effectively enhances the memorization of the word. Moreover, the memorized words could stay in my mind for a long time. It is an effective app of remembering words, and I gained a lot. . . "

D56W3EG:" . . . Through one-week learning, I feel that my memory time for words has increased. This vocabulary learning app is very effective. . . "

D53W5EG:" . . . the effects of learning and reviewing words via the app are becoming better, I will keep working on the app. . . "

D8W8EG:" . . . The more I use this app, the more I get used to it. Remembering words is getting more robust, and the effects are getting better. . . "

4 Reasonable

-in learning 10 words at a time

D23W2EG:" . . . learning 10 words at a time did not cost me much time. Also, after 4 times' review, the words were kept in my mind and not easily forgotten like wordlist learning. . . "

D31W2EG:" . . . using the app to learn 10 words per time outside the class is reasonable and easy. . . "

D34W2EG:. " . . . Through one week, I became more familiar with the 10 words, which left me a more profound impression and understanding of these words. So the number of 10 words one week is good with me. . . "

D27W9EG:" . . . the number of 10 words is not too much every week, which would not make me feel stressful. . . "

-in 5-time schedule per week

D25W2EG:" . . . For the first time, I find that using this app to recite words is very flexible, attractive, which is equipped with words, example sentences, parts of speech, pronunciation, and pictures, leaving a

profound impression on me. For the second time, 9 hours later, I meet the 10 words again, they look very familiar to me. For the third time, I already have a basic understanding of the words, my eyes were no longer limited to words, but I started to pay attention to its usage. For the fourth time, I feel the 10 words are already in my mind and never feel so easier to memorize words. For the fifth time, after reviewing the words again, at this time, I felt the ten words had already blended with me. So this five-time arrangement for learning words via the app is reasonable and excellent. . . "

D44W3WG:" . . . reciting the word based on the five-time week plan left a deeper impression on my mind than before. So it is worthwhile learning vocabulary by the five-time week arrangement. . . "

D38W5EG:" . . . The teacher gave us the five-time schedule of the app so that we didn't have any pressure to learn words. . . "

5 Satisfied

-with an increase in vocabulary size

D32W6EG:" . . . Even if I feel noisy for a day, there is a time when I feel fulfilled and satisfied, that time is my vocabulary learning time with the app. As my vocabulary size increases every day, I will become more and more addicted to it. . . "

D6W7EG:" . . . It's another full week, and my vocabulary size increases day by day. I feel very satisfied. . . "

D20W9EG:" . . . my vocabulary size is increasing; the sense of accomplishment is getting higher and higher; it is another satisfying week. . . "

6 Fun

-in the process of learning and remembering words

D10W3EG:" . . . Learning words via the app becomes interesting, not as dull as before. . . "

D8W5EG:" . . . I feel that memorizing words has also become a fun thing, easy and fun. . . "

D14W8EG:" . . . In the process of memorizing words, there will be some pictures related to the meaning of the words. This will alleviate the boring of reciting words and add more fun. . . "

D16W9EG:" . . . The more I used the app, the more fun I felt. . . "

7 Easy

-in memorizing words

D41W3EG:" . . . It took a long time to memorize the words for the first time, but it became easier to remember them for the second time, and after each review by the third, the fourth and the fifth time, I found that the words were easy to remember. . . "

D29W9EG:" . . . The pictures of new words appear in the app, which can deepen my understanding of the meaning of words, so it is easier to remember them. . . "

D46W9EG:" . . . It feels easy to memorize a lot of words through the app. The words once costing me a long time to memorize only need a while to stay in my mind now. . . "

D48W9EG:" . . . I start to memorize the words skillfully and feel easier than ever. . . "

8 Useful

-in the pronunciation of words

D21W2EG:" . . . the app can teach me how to pronounce the words when I can not read them. . .

D31W3EG:" . . . using the app to review words could correct my pronunciation. . . "

D39W3EG:. " . . . before I could recognize many words but can not read them out. So my English is called "dumb" English. Now with the app, I can pronounce the words correctly. . . "

- in increasing interest in English

D43W4EG:" . . . after using the app for three weeks, my interest in English learning is much improved. . . "

D51W7EG:" . . . with the increasing number of using the app, I become more interested in learning English. . . "

-in memorizing words

D7W2EG:“ . . . I think this app is very useful, the words I remember are firm in my mind, and it is not easy to forget. Learning wors is not in quantity but in quality and how long I can retain the words. . . ”

D35W2EG:“ . . . After five times of learning, I found that memorizing words is more durable than before, remembering them more deeply and easily associating the form with the meaning of words. Generally speaking, it is a very useful app. . . ”

D38W5EG:“ . . . The process of memorizing words has accelerated again this week. Besides, I think using this app to remember words is very helpful, and it suits me very well. . . ”

-in increasing confidence in English

D25W2EG:“ . . . After using the app, my heart has lighted a raging fire, and my confidence in English comes back. . . ”

D34W2EG:“ . . . I believe that as long as I insist every week, there will be more gains in English words, even my English proficiency. . . ”

D15W5EG:“ . . . Memorizing words via the app is making me feel better, and my vocabulary size is continuously improving, which can also increase my confidence in learning English. . . ”

D27W9EG:“ . . . After 8 weeks, I feel that this way of learning words is more scientific, the number of 10 words is not too much every week, which would not make me feel stressful and make me retain them more robust. So I become confident in English learning. . . ”

9 Willing to persist

-in learning words via the app

D34W4EG:“ . . . It's said that it takes 21 days to form a good habit. After three weeks, I hope I have already developed a good habit of memorizing words via the app. I hope that I will go further on the way of remembering words. . . ”

D47W4EG:“ . . . Gradually, I developed the habit of memorizing words via the app, military training makes me very tired, and I am a bit unfocused when learning words in the app. It takes a longer time than previous

weeks, but the effects are acceptable. If I can persist, I believe I can retain more words, and persistence is a victory. . . "

D32W6EG:". . . Memorizing words is getting more relaxed, and more vocabulary is accumulated. I hope I can persist in learning words via the app. . . "

D24W8EG:" . . . After seven weeks' words learning, I have also remembered more words, especially the review over and over again made the words leave a deep impression on me. I will persist in the future. . . "

10 Difficult

-in sticking to the schedule during military training

D43W4EG:" . . . Because of military training, the arrangement each day was full. It was challenging to stick to the five-time plan to learn words. . . "

W52W4EG:" . . . During the military training, it was challenging to learn and review words by the time schedule, for we were too tired. . . "

D32W6EG:" . . . After studying for a few weeks, I found that the most challenging thing to remember is not the words but to learn the words strictly by the time schedule. . . "

-in remembering the pronunciations and meanings of all words

D24W6EG:" . . . but it was difficult to remember the pronunciation and meanings of every word completely. . . "

D13W9EG:" . . . sometimes I can not match the pronunciation of the word with its spelling. . . "

D45W9EG:" . . . after using the app for many weeks, it became easy for me to confuse some words with other words. . . "

-in recalling the words

D42W3EG:" . . . sometimes my memory of the words becomes blank when I shut down the app. . . "

D52W7EG:" . . . I felt I could not recognize the words after seeing them if I switched off the smartphone. . . "

APPENDIX Q

The Representative Diaries concerning the Categories of Feelings about the Wordlist Learning from the Control Group

1 Good

-with the number of 10 words at a time and the schedule of five times per week

D9W2CG:" *. . . This five-time week plan is very suitable for me. It allows me to memorize words with a plan and do not memorize them blindly like before. Three-month summer vacation. It leads to decreased self-control, so this five-time week plan for learning words outside class is beneficial. . . "*

D14W2CG:" *. . . when I first saw the words, I had a strong sense of strangeness. By the third time, I became familiar with the words, and I remembered the words. By the fifth time, I was thoroughly familiar with them. So this five-time schedule was good for us to be familiar with the words. . . "*

D16W3CG:" *. . . It took me half an hour to recite the 10 words for the first time, and I thought I remembered them. But I still feel strange when I learn them for the second time. After four times' review, I thought I remembered them. So this five-time week schedule is helpful. . . "*

D25W8CG:" *. . . I have used this method several weeks with learning 10 words per time, and it took me more than 10 minutes to memorize them each time. Remembering these 10 words becomes more and more firmly. . . "*

D57W9CG:" *. . . By comparing the words learning in the past with the current method of learning 10 words five times a week, I feel this method easy. Vocabulary learning is not on how much I learn, but how much I can keep them in mind. In the past, I tried my best to learn as many*

words as I can one time, and I forgot most of them after closing English textbooks and did not review them any longer. . . ”

2 Tedious

-in learning and reviewing words

D40W3CG:“ . . . I was tired of learning words with the wordlist, for it is challenging for me to learn and quick to forget. . . ”

D33W5CG:“ . . . it was annoying and painful for me to spend much time learning the wordlist. . . ”

D13W2CG:“ . . . For the first time, it was fresh for me to see the wordlist. But later, I did not want to see the words on the wordlist again, for it was too painful for me to review them. . . ”

D40W3CG:“ . . . the review process with the wordlist is annoying. . . ”

D23W7CG:“ . . . I felt no passion for using the wordlist to review CET4 vocabulary. . . ”

3 Weak

-in retaining words

D8W2CG:“ . . . English words have many meanings, which take me much time to recite. It’s a torture to me. . . ”

D5W3CG:“ . . . The meaning of words was easy to be confused with others. Hence it was difficult to remember the words. Missing or reversed letters often happened to me when I tried to spell the words. . . ”

D14W3CG:“ . . . The meanings of words are easy to be confused with others, and it is difficult to remember all meanings of the words. Missing or reversed letters often happen to me when I was spelling the words. . . ”

-in efficiency

D51W5CG:“ . . . I found that I learned vocabulary slowly and forgot them quickly. The effectiveness of memorizing words with the wordlist was very low. . . ”

D16W9CG:“ . . . Learning the words is slow, and forgetting them is quick. So the efficiency of wordlist learning is low. . . ”

-in pronouncing words

D10W2CG:" . . . when reading words, I felt my tongue was not smooth. And the pronunciation of the words was challenging for me, and it was not accurate. . . "

D14W3CG:" . . . I can not pronounce the words when I use the wordlist to learn vocabulary. . .

D45W4CG:" . . . after seeing some words, I know the meanings of them. But I can not read them, even if I try my best to pronounce them, I feel my pronunciation is weird. . . "

CURRICULUM VITAE

Ma Xingxing was born on September 21, 1986 in China. He received a Bachelor of Arts degree in English Language from Zhongyuan University of Technology in 2009. Three years later, he earned a Master of Arts degree in Foreign Linguistics and Applied Linguistics from Jiangxi Normal University in 2012. In 2015, he began to study for a Ph. D degree in English Language Studies at the School of Foreign Languages in Suranaree University of Technology, Thailand. Studying from his M. A to Ph. D. , he has published seven academic articles, five in Chinese journals and two in international journals (one Scopus-indexed and the other ERIC-indexed). Also, he is a senior lecturer of English in School of Foreign Languages at Anshun University, China, where he teaches college English for non-English major undergraduates and English writing for English major students. His research interests include EFL teaching and learning, pragmatics, and technology-assisted EFL vocabulary learning.