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Mobile Flashcard Application for Vocabulary Learning: Effects on Development of Vocabulary Knowledge

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Responding to the need of empirical research on the use of mobile phone applications (apps) for language learning in the current literature, the present study conducted a comparative study using a smartphone flashcard app and a traditional vocabulary learning tool, a paper-based flashcard, in order to determine if the new learning tool, flashcard app, presented effectiveness on learner development of vocabulary knowledge. Two college EFL classes in Korea were participated in this study. One EFL class of the experiment group (n=43) studied their target vocabulary using the smartphone flashcard app while the other EFL class of control group (n=40) studied the same vocabulary words on paper-based flashcards. The mixed research methods that combined both quantitative (e.g., a pre- and post-test, and a questionnaire) and qualitative approaches (e.g., a semi-structured interview) were employed. The results showed that the learners who used the flashcard app outperformed the learners who studied the paper-based flashcard in vocabulary growth. In addition, the learners showed an overall positive attitude and perception toward the use of the flashcard app for their learning. This study suggests that the flashcard app is useful to develop learners' vocabulary knowledge and can be a new effective vocabulary learning tool in the classroom.

[mobile-assisted language learning/mobile-based vocabulary learning/mobile flashcard application/vocabulary learning/flashcards]

I. INTRODUCTION

Rapid development in mobile technology has attracted many educators to integrate various mobile devices into their classroom for an effective learning environment (Lan

& Huang, 2012). The adoption of mobile technology into education provides new learning opportunities and flexibility in learning; for example, learning can occur anytime and anywhere by engaging learners in online tasks outside of classroom. In addition, frequent engagement and collaboration are encouraged among learners and between teachers in response to the availability of immediate access to various educational information and resources and saving them on their mobile devices through internet-access capability (Dalmi & Albion, 2014). This modality can also help to develop students' ownership of learning, which may lead to positive learning experiences and increase students' motivation of learning (Kim, Rueckert, Kim, & Seo, 2013; Kukulska-Hulme, 2009). The term 'mobile technology' refers to any device that is portable and can perform a wide variety of tasks with wireless, cellular network capability, ranging from laptops, tablet PCs, personal digital assistants (PDAs), to mobile phones, smartphones, and the recent Apple watch.

Among all mobile devices, mobile phones are probably the most popular as they have already become a routine part of our lives (Başoğlu & Akdemir, 2010). Mobile phones have been designated as a new possible learning tool in education with its advantageous features such as immediacy, accessibility, flexibility and portability (Song, 2008; Zhang, Song, & Burston, 2011). With such advantageous features, learners can access learning contents and information with ease and quick and learning can occur in learners' preferred time and place. In addition, sending the 'push messages' to individual learners' mobile phones can bring learners' attention to learning material easily; thus, 'maximizing the exposure to the learning contents' (Lu, 2008; McNicol, 2004). Furthermore, 'the bite-sized lessons' found in most of mobile-phone learning research have been another merit to learners since learners feel more manageable and achievable in studying mini-sized lessons given to them via mobile phone than the usual lengthy and detailed lessons in traditional classroom (Lu, 2008; McNicol, 2004).

More recently, the emergence of a new, state-of-the-art model of mobile phone, known as 'smartphones' brought the new potential and possibilities for language learning. Smartphones (iPhones, Androids and Windows Phones) have computer-like functions enabling browsing, information searching, and saving resources and more advanced capabilities such as touch screen technology and an operating system that offers an open and reliable platform where users can install third-party applications (apps). The fact that smartphone users can connect to a virtual store (e.g., Apple store or Google store) on the phones and download a lot of apps created by various companies according to their needs makes smartphones exceptional and functional. The limitless smartphone apps extend the capability of the phone and deliver more customized experiences. Therefore, the innovative features of smartphones are expected to provide

many possibilities that can extend learning opportunities and even change the learning at school.

For language learning purposes, there are more than hundreds of educational apps available from the app store. Amongst all, *Duolingo, Babbe, Tandem, Memrise, Busuu* are the most popular and downloaded language learning apps available (Hill, 2018). These kinds of apps provide various mini lessons (words, phrases, grammar rules, etc.), communicative language practice, tasks, opportunities to speak with native speakers (Tandem), and so on. By using these types of language learning apps, learners can engage in various activities to develop language skills and motivate their learning.

While there is a great potential and versatility of using educational apps in language learning as a way of making learning more effective and enriching, there is still a critical need for more research on using apps as a language learning tool in general. Currently, little empirical research has been conducted to examine the effects of using smartphone flashcards app for vocabulary development. As Richards and Renandya (2002) stated, "vocabulary is a core component of language proficiency and provides much of the basis for how well learners speak, listen, read and write" (p. 255). Numerous techniques and technologies have been employed to enhance the development of learners' vocabulary knowledge (e.g., words lists, flashcard and online/mobile-learning) (Khoii & Sharififar, 2013). Yet how vocabulary should be learned is a still crucial question which merits further exploration. Thus, the current study aims to investigate the effectiveness of using one of the popular vocabulary learning apps, *Cram*, focusing on learners' development of vocabulary. More specifically, it seeks to explore whether using a new tool, flashcard app can better improve learners' vocabulary knowledge than using traditional paper-based flashcard, which is proven effective in increasing learners' vocabulary knowledge.

II. LITERATURE REVIEW

1. Vocabulary Learning via Mobile Phones

Vocabulary knowledge plays a crucial role to learners' overall language acquisition (Moghadama, Zainalb, & Ghaderpour, 2012; Nation, 2001). Language learners need adequate vocabulary knowledge and effective strategies for learning new words (Chien, 2015; Nation, 2001). In recent years, vocabulary has been the most frequently studied language areas supported by technology (Stockwell, 2007). The wide range of technological tools has been used from online dictionaries, vocabulary learning educational websites, corpora and concordancing, courseware programs, and computer-mediated communication technologies, such as email, text messaging, instant messaging

and bulletin boards, etc., to recent mobile devices. Numerous studies support that vocabulary learning through technological tools can be more effective than using traditional vocabulary learning such as word lists or vocabulary flashcards (Chien, 2015). With the aid of technology, learners can be easily exposed to 'spaced repetition' of vocabulary words which is proven to be more effective than mass repetition (Nation, 2001). This frequent spaced exposure to target words "enhances the information processing activities, makes the activation and recognition automatic, and leads to greater retention" (Hulstijn, 2001; cited in Lu, 2008, p. 516).

With the recent development of mobile technologies, there has been growing interest in using mobile devices for language learning purposes. In particular, the pedagogical use of mobile phones has been frequently researched to explore its possibilities as a new vocabulary learning tool (e.g., Başoğlu & Akdemir, 2010; Kennedy & Levy, 2008; Lu, 2008; Stockwell, 2007, 2010; Stockwell & Liu, 2015; Thornton & Houser, 2005; Zhang et al., 2011). Among various features and functions that mobile phones can offer, current literature mainly focuses on the use of Short Message Service (SMS) messages to provide learners with vocabulary lessons (e.g., Cavus & Ibrahim, 2009; Kennedy & Levy, 2008; Lu, 2008; Zhang et al., 2011).

For example, Lu's (2008) study examines the effectiveness of SMS vocabulary lessons delivered to learners' (15 high school students in Taiwan) mobile phones during a two-week period. Each SMS lesson had two target words provided with learners' first language (Chinese) translation, as well as the syntactic categories of target words, and was sent twice each day during learners' commuting time. The total of 28 target words are used. The findings show that mobile phone learning group outperformed the paper-based learning group in terms of vocabulary gains. However, there was no significant difference between two groups in the delayed tests. This study reflects that SMS vocabulary learning through mobile phone enhances learners' motivation, which leads to increase learners' engagement in the learning activity; as well as exposure to the target words; thus, it overall helps to develop learners' vocabulary knowledge effectively. Similarly, Zhang et al. (2011) reexamine the effectiveness of using mobile phone SMS messages for vocabulary learning compared to the traditional use of print material from a Chinese students' perspective, considering previous studies were region-specific and using small sample size, a short-learning cycle, and small target vocabulary size. Thus, this study used a total of 130 target words and each lesson, containing five items at a time, was sent to learners (40 university students in China) twice a day (12:00 pm and 5:30 pm) during 26 days. The results showed that the experiment group who studied vocabulary through SMS had greater vocabulary growth than the control group who studied same material on paper; however, the results of the delayed tests fail to show any significant differences between two groups. As found in the results of the studies of Lu

(2008), Zhang et al. (2011), the effectiveness of 'spaced repeated vocabulary learning' (Nation, 2001) in the previous studies is also supported in mobile phone-assisted vocabulary learning. The advantageous feature of mobile phone, 'portability', 'accessibility', 'immediacy' and 'flexibility' makes SMS vocabulary lesson more effective by making it easier for repeated exposures to the target words and increasing engagement in learning activity in a spaced repetition way; thus it helps to develop vocabulary knowledge.

Besides SMS messages, Thorton and Houser's (2005) study used 'email' to deliver vocabulary lessons to learners' phone in order to explore the effectiveness of using mobile phone for vocabulary learning in Japan. In addition to utilizing the features that mobile phone offers (e.g, SMS messages, and email), there was experimental research that adopts vocabulary learning program running on mobile phone to examine its potential and effectiveness on learners' vocabulary learning (e.g., Başoğlu & Akdemir, 2010; Stockwell, 2007, 2010; Stockwell & Liu, 2015). The studies of Stockwell (2007, 2010) and Stockwell and Liu (2015) adopt a prototype mobile-phone based intelligent vocabulary tutor system, *VocabTutor*, to examine its educational possibilities and learners' pattern of usage. In addition, Başoğlu and Akdemir (2010) also used a vocabulary acquisition program, *ECTACO Flashcards* to examine the effectiveness of mobile phone vocabulary learning compared to the traditional vocabulary learning tool, paper flashcard. The results showed that *ECTACO Flashcards* running on mobile phone enhanced learners' achievement of target words more than the use of paper flashcards. In addition, learners found learning vocabulary using mobile phones helpful and entertaining. Learners had ample opportunity to engage in vocabulary learning activities anytime and anywhere, especially outside the class because they brought their mobile phones with them every day. Therefore, the data suggest that adopting a vocabulary learning program on mobile phones might offer an effective environment for vocabulary learning.

In recent years, the empirical research that adopted the smartphone apps for vocabulary learning has been increasingly conducted as with the recognition of educational possibilities of the smartphone and its apps for language learning. Kim and Hur (2016) compared three types of smartphone apps, *KakaoTalk, NaverBand*, and *Socrative*, in terms of the effectiveness on both cognitive and affective development in the vocabulary learning. The findings indicated that the group that used *NaverBand* showed the highest improvement in their vocabulary performance, followed by *Socrative* and *KakaoTalk*. With regards to affective domains, the *Socrative* group received the highest result on the factor of students' satisfaction while *KakaoTalk* showed the highest result on the factor of student's interest. Min and Lee (2018) examined the effects of using a vocabulary learning app, *Wordybuddy* on Korean elementary school learners'

English vocabulary learning and attitudes. The results showed that there was a significant increase in the comprehension and production scores for both the *Wordybuddy* group and a control group. However, the effects on long-term memory were not found in the both groups. In the affective domain, interests and confidence scores were found to be significant for the upper-level *Wordybuddy* group and lower-level control group. In addition, Sohn (2018) used a vocabulary game app, *Englider 2.0* for Korean middle school students' vocabulary learning. The result indicated that a game app learning group outperformed a control group in vocabulary performance and reported the students' positive attitudes toward game app-based vocabulary learning. Recently, Jin's (2018) study adopted both a flashcards app and a social networking site app for mobile collaborative learning and examined their effectiveness on learner development of vocabulary knowledge. The result reported a successful outcome in the learners' vocabulary growth and the effectiveness for short-term and long-term retention. However, the result of Jin's (2018) study fails to show that a contributing factor of a significant increase in vocabulary knowledge is either the flashcard app or the social networking site app for mobile collaborative learning or both.

Since it is an emerging phenomenon that using an mobile app for educational purposes, more empirical studies on these topics are needed to fully reveal the benefits and drawbacks of employing the apps as a pedagogical tool. To date, little information was found to examine the effects of using an mobile flashcard app for developing vocabulary knowledge. Therefore, this study is an attempt to fill the void in the literature and deemed significant since it adds to current knowledge on mobile app-based language learning.

2. Flashcards as a Vocabulary Learning Tool

Flashcards are the most common and widely-used learning and study tools in any subject areas with various benefits such as easy to make, enabling active recall and self-reflect on the studying materials, promoting repetition and so on. Flashcard can be best used with the learning technique of 'spaced repetition' by helping learners to study the same material with repetition in a spaced schedule, which is useful to retain the information in the short or long-term memory. In language learning context, flashcard is created to consist of two sides, one of which has the vocabulary word written in learner's second language and the other of which has the translation in learner's native language and pronunciation (Azabdaftari & Mozaheb, 2012). The use of flashcard has been long proven to be effective in increasing learners' vocabulary knowledge (e.g., Komachali & Khodareza, 2012; Schmitt & Schmitt, 1995). For example, a study conducted by Komachali and Khodareza (2012) showed that the experimental group who used paper-

based flashcard performed significantly better in vocabulary gains, compared to the control group of traditional vocabulary instruction without such aids. It is recommended that learners need to be familiar with using vocabulary learning tools such as word lists or flashcard, which are shown to be effective and useful in order to expand vocabulary knowledge (Nation, 2001).

With the technological advancement, the focus has been changed from using paper-based flashcard to adopting various computer-based flashcard (e.g., *vTrain, Quizlet, Picard, The Word Engine, Cram, Word Champ*, and etc) for vocabulary learning (Chien, 2015). As with computer-assisted language learning (CALL), computer-based flashcard can provide improved and engaging presentation of studying materials with its multimedia capabilities along with various vocabulary learning activities and exercises, which is helpful for increasing learners' performance and motivation (Nakata, 2011). Furthermore, computer-based flashcard can offer more beneficial features than paper flashcard in that it can enable learners to study more unfamiliar, hard items than already known and familiar ones by easily keeping track of learners' performance and providing more targeted practices by controlling sequencing of the words (Nakata, 2011). Lots of empirical research supported that vocabulary learning with computer-based flashcard can increase learners' vocabulary growth significantly better than traditional way of vocabulary learning, regardless of their delivery form (e.g., Hung, 2015; Nakata, 2008, 2011). For example, Spiri's (2008) study showed that learners who studies with *WordChamp*, computer-based flashcard, outperformed in vocabulary gains compared to the control group who studied with the word lists. In addition, Nakata (2008) conducted a comparative study of using word lists, word card, and computer drills for vocabulary learning and findings indicated that the computer-based learning group performed the best in the highest retention rates.

In more recent years, with the appearance of mobile technology, adopting the mobile devices into language education, that is, mobile assisted language learning, has been a drawn significant interest and has become a major topic for discussion and exploration. Since it is a new emerging phenomenon in language education, very few studies have focused on the adoption of mobile phone flashcards for vocabulary learning, compared to using computer-based flashcards. In the current literature, Başoğlu and Akdemir's (2010) study was found to conduct a comparative study of using mobile phone flashcards and paper-based flashcards for vocabulary learning. The mobile phone learning group used the vocabulary acquisition program, *ECTACO Flashcard* to study the target vocabulary items while the traditional learning group studied the same target words with using paper-based flashcards during a six-week time span. The result revealed that the mobile phone flashcard group achieved significant better outcome in vocabulary gains compared to paper-based flashcard group. Jin's (2018) research was

the only study that was found to use a smartphone flashcards app for vocabulary learning. As mentioned in the previous section, Jin (2018) used both the flashcard app and the social networking app for mobile collaborative learning and the result of study revealed that a smartphone app-assisted vocabulary learning group outperformed a traditional vocabulary learning group with a paper-based flashcard. However, the result of study was based on the combination of two learning methods, the flashcard app for vocabulary learning and the social networking app for mobile collaborative learning. Thus, the sole effect of the smartphone flashcard app on development of vocabulary knowledge and its pedagogical implications have yet to be comprehensively investigated. To address these limitations in the literature and respond to the current trends of mobile-assisted language learning, the present study thus explores the educational possibilities of using a smartphone flashcard app for vocabulary learning. More specifically, it attempts to examine whether the adoption of the smartphone flashcard app can better improve learners' vocabulary knowledge than the conventional vocabulary learning of paper-based flashcards. This study raises the following research questions:

Q1. Is vocabulary learning with the mobile flashcard app more effective than vocabulary learning with traditional paper-based flashcards in terms of increasing learners' level of vocabulary knowledge?
Q2. What are the learners' attitudes and perceptions toward the use of the mobile flashcard app for their vocabulary learning?

III. METHODS

1. Participants

This research was conducted at English as a foreign Language (EFL) classes in a public University in Korea. All participants were enrolled in compulsory first-year EFL classes which focused predominantly on improving communication skills, along with expanding their vocabulary knowledge. Participants were required to study textbook materials and participate in various engaging activities as well as studying vocabulary related to course materials. Two EFL classes joined in this study, and the classes met once a week during one 16-week semester. One EFL class of the experiment group consisting of 43 students studied their target vocabulary using the smartphone flashcard app, *Cram,* while the other EFL class of control group, including 40 learners, studied the same vocabulary words on paper-based flashcards. Both groups of students took Oxford English placement test (grammar and vocabulary section) (Allen, 1992) to assess their

level of proficiency, as well as to confirm their homogeneity before the experiment. The mean score of experiment group was 25.67 and that of control group was 26.45 and both of them fell into a pre-intermediate level (scores between 21-30). As indicated in a survey conducted at the beginning of the experiment, the age of participants was between 19 and 20, they owned smartphones and were already familiar with downloading and using various smartphone apps.

2. Procedures

1) Vocabulary Learning Activities

An orientation on how to use the smartphone flashcard app for vocabulary learning was administered in the first week of the semester. The orientation consisted of showing participants how to install the app, *Cram*, from Appstore (i.e., Google store for Android, Apple store for iPhone, etc.), how to log in and find their flashcards for a study, and complete each activity type (games, quizzes, etc.) on the app. To increase students' engagement and motivation, participation in the vocabulary activities was graded as 20% of the overall class score.

Target English words for this study were selected from the textbook materials, and the flashcards for each unit were created by the researcher. These flashcards were made available to students on their app, *Cram,* on their smartphones. Before the experiment, a pre-test was conducted to assess the students' initial vocabulary knowledge so as to carefully choose words unknown to them. Ten to fifteen words per unit with a total of one hundred words were chosen for the experiment.

2) Smartphone Flashcard Application, *Cram*

Cram is a smartphone application available for both iPhone and Android. It also has a website (Cram.com) which can be used on a PC. *Cram* has a wide selection of flashcards already made for learners to choose from, according to the subject categories. Like other flashcard apps, *Cram* lets users make their own cards or edit existing cards to better fit their needs. The interface is simple, easily navigated, and user-friendly. Each flashcard has a front and a back section. As seen in the following Figure 1, on the front side of flashcard, there was a target English word with the phonetic alphabet and information of word class (i.e., verb, noun, adjective etc.).

There are two modes for vocabulary learning on *Cram*: 'memorize' and 'cram'. According to the website of *Cram* (cram.com), 'memorize' mode allows users to study each flashcard a single time until all the cards are finished up, and the performance result

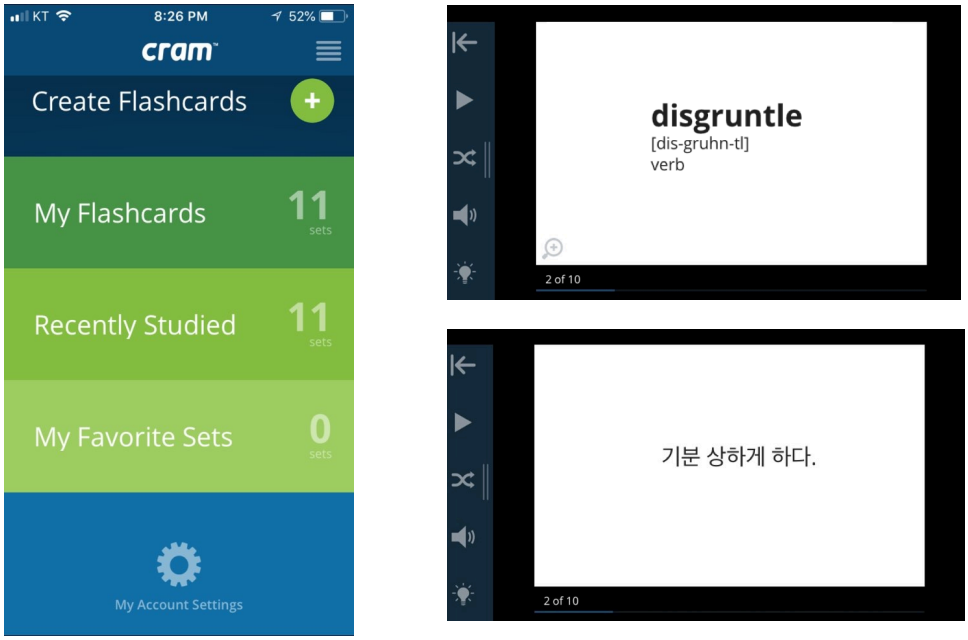
was given at the end. Whereas, 'cram' mode enables users to study each flashcard until they get the correct answer on every single card. After then, the next activity would be available to them.

In this experiment, 'Cram' mode was used to maximize the effects of vocabulary learning through repetition. In addition, *Cram* has 'share' function which allows users to share the flashcard they created with anyone such as classmates or other students in the study group, which promotes collaborative learning. This 'share' function on *Cram* was used in this research when flashcard of this study was sent to the experiment participants.

Cram was expected to allow users to study and review target vocabulary on any occasion they wished, such as during their commuting time (i.e., on the bus or train) or waiting time for friends. With *Cram*, learners were expected to study as many words as possible with little effort.

FIGURE 1

Screenshot of Flashcards on the Flashcard App, *Cram*, on the Smartphone



From week 4 to week 15 (except week 8, midterm exam and week 16, final exam), a total of 11 sets of flashcards each consisting of 8-10 target vocabulary was sent to learners' phones via *Cram*. The total of 100 words were used (see Appendix A). Since spaced repetition was proven to improve vocabulary learning experiences (Nation, 2001), the same set of flashcards were sent to learners twice a week to maximize the effects of

vocabulary learning via the flashcard app. Whereas, the control group was assigned to the same target items but on paper-based flashcards. They were given a total of 11 sets of paper-based flashcards created by the researcher throughout the semester (the total of 100 words). The control group studied the same sets of target words every week.

3. Data Collection and Analysis

The current study employed the mixed research methods that combined both quantitative and qualitative approaches to offer a better understanding and more profound explanation of the research problem. Four instruments were used: these were 1) the vocabulary ability test (in order not to include the words with which learners were already familiar when choosing target vocabulary items), 2) the pre-test and the post-test to explore learners' improvement of vocabulary knowledge, 3) the questionnaire (five level Likert scale: 1-strongly disagree, 5-strongly agree) to gather information about the learners' perception and attitudes towards smartphone app assisted vocabulary learning, and 4) the semi-structured qualitative interviews with 11 volunteer learners from the experiment group (see appendix B for interview questions).

For the vocabulary ability test, a total of 180 words was selected from the textbook materials used in the course to test learners' vocabulary knowledge in order to examine whether learners had already known the words before the experiment. The vocabulary ability test was administered in the first week of the course. The result of the vocabulary ability test can help to choose the target vocabulary words for the experiment since the words that most of learners had already known were removed from the target vocabulary items. Accordingly, a total of 100 target vocabulary words was chosen for the experiment and they were used in both pre-test and post-test.

In order to examine learners' development of vocabulary knowledge for both groups (the flashcards app learning group and the paper-based flashcards learning group), the pre-test was conducted during the second week of the course and the post-test was conducted during the final week of the course. Each pre- and post-test consists of 100 target vocabulary word items and each item gets one point.

For the analysis of quantitative data, descriptive statistics and two independent *t*-tests were administered to see if there is any difference between the mean scores of the pre- and post-tests for both groups. It examined if each treatment for each group (a smartphone flashcard app and paper-based flashcards) had any effect on the development of vocabulary knowledge after the experiment. In addition, a paired *t*-test was conducted to see if there were any difference between the mean gain scores of the both groups (gain scores equal post-test minus pre-test) in order to explore whether one

treatment could significantly better enhance the performance of participants than the other treatment.

Furthermore, the questionnaire (five level Likert scale) was conducted at the end of the semester (after the post-test) in order to examine perception and attitude of the learners in the experimental group toward the use of the smartphone flashcard app for vocabulary learning. The results were analyzed by the means and standard deviations to indicate the numerical level of their experiences in using the new tool, the flashcard app for their vocabulary learning.

Finally, the semi-structured interview with 11 volunteer learners from the experiment group was conducted at the final week of the course (16 week). Using the qualitative interview method for the research helps to uncover rich information and critical insights on the views, experiences, and beliefs of participants, which can not be obtained from purely quantitative methods. Thus, this study used semi-structured interview to provide a deeper understanding and meaning behind learners' experiences and offer detailed insights about using the flashcard app as a vocabulary learning tool (see appendix B for interview questions).

For the analysis of qualitative data, the recorded interview was all transcribed and analyzed with employing a descriptive qualitative analysis. That is, all the transcribed data was read thoroughly and repeatedly and then categorized and labeled by the coding process. Specifically, structured coding was employed with using research questions as a framework for the analysis. Accordingly, several issues and themes were identified, such as perceived features of using the flashcard app, some technological issues, and areas for improvement.

IV. RESULTS

1. Effectiveness of Using Mobile Flashcard Apps for Vocabulary Learning Compared to Traditional Paper-Based Flashcards

The descriptive analyses of this study which shows the summary and basic features of the quantitative data result are presented in the Table 1. The mean scores between the pre- and post-test of each group showed that there was an enhancement in the scores of each group after treatment. To be specific, the mean scores of a smartphone app learning group increased from 26.67 to 49.67, and those of paper-based flashcard learning group improved from 25.75 to 40.20. Overall, there was a general improvement in learners' performance and vocabulary knowledge development for both groups. The post-test

result of the experiment group indicated a relatively high standard deviation (SD = 20.77) since some students scored very low and high, respectively while many of learners scored around the average; thus, the data points were spread out over a wider range.

TABLE 1
The Descriptive Analysis of Pre- and Post-Test Results of Both Groups

		N	Mean	SD	df	*t*	*p*
Pre-test	Experimental Group	43	26.67	16.44	81	.27	.79
	Control Group	40	25.75	14.93			
Post-test	Experimental Group	43	49.67	20.77	81	2.27*	.03
	Control Group	40	40.20	16.81			

p-value *$p < .05$

As shown in Table 1, the result of comparison of pre-test scores between experimental group (the smartphone flashcard app, *Cram*) and control group (the paper-based flashcards) was generated by an independent sample *t*-test. For the reliable and valid results, it is important for participants to be in the same proficiency level before the experiment. The result showed that the mean score of participants in the smartphone app learning group was a little bit higher than that of participants in the control group (M = 26.67, 25.75, respectively). However, the *p* value ($p = .79$) which is greater than .05 indicated that there was no significant difference between the two groups before the experiment, thus supporting that both groups were at the same vocabulary level and not initially different before participating in this study.

TABLE 2
Pre-Post Test Comparison of the Experimental Group and Control Group

Pre-Post Test	Mean	SD	df	*t*	*p*
Experimental Group	-23.00	10.75	42	-14.04**	.00
Control Group	-14.45	9.60	39	-9.52**	.00

p-value **$p < .01$

The Table 2 presented the results of differences between the mean scores of pre- and post- test for the both groups. The differences between the mean scores of pre- and post-test of the experimental group ($t(42) = -14.04$; **$p < .01$) showed that the *p* value was less than .01 and thus, statistically significant. To be specific, the post-test score (M = 49.67, indicated in Table 1) is significantly higher than the pre-test score of the

experimental group (M = 26.67, indicated in Table 1). This finding revealed that using a mobile flashcard app, which was a new instruction tool for vocabulary learning, results in a positive and successful outcome for improving learners' vocabulary knowledge. Whereas, the control group used the traditional vocabulary learning tool, the paper-based flashcards, which have been long proven effective in the literature. It is also important to see whether there was a significant difference between the vocabulary knowledge level of the control group before and after the treatment. As shown in Table 2, the result of the differences between the mean scores of pre- and post- tests of the paper-based flashcard learning group was significant, as well ($t(39) = -9.52$; $^{**}p < .01$). That is, vocabulary knowledge of participants in the control group was also significantly increased after the treatment. This finding aligned with many other studies in current literature which supported the effectiveness of paper-based flashcards on increasing learners' vocabulary knowledge.

As elaborated above, the present study revealed that both the smartphone flashcard app and paper-based flashcards were effective and successful for increasing learners' vocabulary knowledge. In addition to this result, it is meaningful and compelling to further investigate whether there was a difference between the mean gain scores of both groups as a means of determining whether one platform can be more effective than the other with regard to increasing learners' vocabulary growth.

TABLE 3

The Comparison of Mean Gain Scores of Both Groups

Groups	N	Mean	SD	df	*t*	*p*
Experimental Group	43	23.00	10.75	81	-3.81**	.00
Control Group	40	14.45	9.60			

p-value $^{**}p < .01$

Table 3 presented the result of the comparison of mean gain scores of both groups. The result showed that there is a significant difference between the mean gain scores of the experimental group (M = 23) and that of the control group (M = 14.45) ($t(81) = -3.81$, $^{**}p < .01$). That is, the mean gain scores of experiment group (M = 23) were significantly higher than those of the control group (M = 14.45). This finding revealed that using the flashcard app on smartphones improved learners' vocabulary knowledge much further than using traditional way of vocabulary learning, paper-based flashcards.

2. Learners' Attitude and Perception toward a New Learning Tool, Smartphone Flashcard App for Vocabulary Learning

After the experiment (Week 15), the online survey was carried out with all the learners in the experiment group (n = 43) to examine learners' perceptions and attitudes toward the new learning experiences of using flashcard app for vocabulary learning. In the CALL literature, learners' positive attitude and perception is a good indicator that a new technological tool can be successfully integrated in the language classroom.

TABLE 4

Perceptions and Attitudes of the Learners About Using the Mobile Flashcard App for Vocabulary Learning

Statements	Mean	SD
1. Using the mobile flashcard app for vocabulary learning is useful.	3.55	.79
2. Using the mobile flashcard app makes learning vocabulary more interesting.	3.55	.82
3. Using the mobile flashcard app is convenient for vocabulary learning.	3.83	.57
4. Using the mobile flashcard app helps me to regularly review the vocabulary.	3.58	.82
5. Using the mobile flashcard app helps me to memorize new words.	3.13	.80
6. Using the mobile flashcard app for vocabulary learning motivates me to learn new words.	3.53	1.05
7. Using the mobile flashcard app provides me more opportunities for engaging in vocabulary learning activities outside of the classroom.	3.79	.88
8. Using the mobile flashcard app for vocabulary learning increases my vocabulary knowledge.	3.25	1.02
9. Mobile app-based learning has more beneficial features than a traditional classroom.	4.00	.87
10. Overall, adopting the mobile flashcard app into a traditional classroom was effective in developing vocabulary knowledge	4.18	.76
Total	3.64	.84

As shown in Table 4 , the learners in this study felt strongly that adopting smartphone app into a traditional classroom was effective in developing their vocabulary knowledge (no 10, the highest mean score (M = 4.18)) and mobile app-based learning has more beneficial features than a traditional classroom (no 9, the second highest mean score (M = 4)). This indicated that learners showed a positive attitude toward implementing a

smartphone app for their vocabulary learning and accepted this new modality and changes to the traditional classroom as a better and more effective learning environment.

With the regard to features of the smartphone platform, learners considered using the flashcard app as being convenient (no 3, the third highest mean score (M = 3.83)), which showed that they felt comfort in using the app for vocabulary learning and identified with ease of use. This interpretation is further corroborated by statements made during the interviews, where students expressed that it was 'easy to access' to flashcards whenever and wherever they wanted to study vocabulary as it was on their smartphones which they carried with them every day. Consider, for example, the following:

> [1] It was very easy and convenient to use flashcards. I usually studied the words when I had spare time such as when commuting on the subway or waiting time for friends to come. I liked it because flashcards were already on my phone.

The advantageous feature of using smartphone, easy accessibility, made participants feel that it was convenient and comfortable when they needed to use the flashcards for studying. It was also found that learners could save time for studying since they could utilize their spare time such as commuting time (on the bus or train) or time spent waiting for friends, by using the flashcard app whenever and wherever they need it, which could maximize time for studying.

In addition, learners agreed that flashcard app-based vocabulary learning enabled them to have more opportunities for engaging in vocabulary activities outside of the classroom (no 7, the fourth highest means score (M = 3.79)) and to regularly review the vocabulary words (no 4, the fifth highest mean score (M = 3.58)). This indicated that using the flashcard app was beneficial in increasing exposure frequency to target words, which could lead to development of vocabulary knowledge (Chen & Truscott, 2010).

With regard to increasing frequency of exposure to target words, some learners expressed that researcher's reminder link to the flashcard app which was sent to learners' phone twice a week was helpful to promote vocabulary learning, as seen in the following interview excerpts:

> [2] I liked the reminder link. It got me to open the app and go for it. I think I never opened the app when there was no reminder.
>
> [3] The reminder kept me reviewing the words.

From the interview data, the reminder link played the role of calling learners' attention to vocabulary learning; thus, it increased the learning opportunities. In addition, it enabled learners to study the target vocabulary words in a 'spaced repetition' way,

which was proven for effective vocabulary learning. This suggested that appropriate teacher intervention such as giving learners the reminder link to the flashcard app is recommendable to make learning more effective and engaging.

Overall, the findings showed that learners had a positive attitude and perception toward the implementation of the new learning tool, smartphone flashcard app for vocabulary learning (the total of mean score (M = 3.64) in Table 4). In addition, the learners positively regarded smartphone-based learning as a better, more effective and more engaging learning environment.

V. DISCUSSION AND PEDAGOGICAL IMPLICATION

Research Question 1. Is vocabulary learning with the mobile flashcard app more effective than vocabulary learning with traditional paper-based flashcards in terms of increasing learners' level of vocabulary knowledge?

The present study revealed that using the mobile flashcard app improved learners' vocabulary knowledge much further than using traditional way of vocabulary learning, paper-based flashcards. Accordingly, using the mobile flashcard app is more effective than using traditional, paper-based flashcards in terms of developing learners' vocabulary knowledge. The findings of this study are consistent with those of previous studies (e.g., Başoğlu & Akdemir, 2010; Lu, 2008; Thornton & Houser, 2005; Zhang et al., 2011), which supported the effectiveness of using mobile phones for vocabulary learning and its superiority in increasing learners' vocabulary knowledge when compared to the traditional vocabulary learning technique, paper flashcards. However, while previous studies mostly focused on using SMS messages, emails or vocabulary learning programs on mobile phones, this study primarily attempted to use the mobile app for vocabulary learning, specifically the mobile flashcard app, which has been rarely researched in the current literature. Thus, positive possibility of using the mobile flashcard app for a new vocabulary learning tool was supported in this study.

Research Question 2. What are the learners' attitudes and perceptions toward the use of the mobile flashcard app for their vocabulary learning?

The findings showed that the learners had an overall positive attitude and perception toward the implementation of the new learning tool, smartphone flashcard app for vocabulary learning. The learners in this study positively regarded smartphone app-based learning as effective for their learning performance and accepted this new change

in their traditional classroom as a better, more useful, and more engaging learning environment. The success of mobile learning depends on learner's acceptance of technology and positive attitudes toward it (Hashim, Yunus & Embi, 2016). Accordingly, this study's finding of learners' positive attitude and perception can be a good indicator of effectiveness of the new tool, flashcard apps, in enhancing learners' performance; thus, bring a successful outcome of learner development of vocabulary knowledge.

With the regard to the feature of using the smartphone app, 'convenience' was the factor that most of learners agreed on. It seemed that using the smartphone app, with which learners were already familiar as they carried their smartphones around all the time, was the reason learners felt comfortable and were willing to use it for their learning. In addition, with its easy accessibility, learners seemed to have more opportunities for engaging in vocabulary activities and regularly reviewed the vocabulary words outside of the classroom. This finding indicated that using the flashcard app can be beneficial in increasing the number of encounters with the target vocabulary, which can lead to development of vocabulary knowledge (Chen & Truscott, 2010).

Notably, this research hasn't found any complaints about the small screen size or discomfort of keyboards of the mobile phone when it was used for educational purposes from the interview participants, which is incongruent with the former studies of Stockwell (2008, 2010) and Thornton and Houser (2002). Since the flashcard app offered the text auto sizing function and the whole screen of the mobile phone was used to show one word per page, the vocabulary words were presented effectively within a small screen. It is meaningful to note that a smartphone app with its advantageous functions can make a small pocket-size of mobile phone being an effective and beneficial learning tool.

Overall, the present study demonstrated that the new attempt of adopting the smartphone flashcard app for vocabulary learning was successful and it brought more effective and better outcome than the traditional vocabulary learning tool, the paper-based flashcard. In addition, learners' positive attitude and perception about this new learning experiences indicated that learners accepted the flashcard app as a new learning tool and it can be a preferred way of learning vocabulary.

There are some pedagogical implications of this study. First, when vocabulary learning is needed in any type of EFL courses, the use of a smartphone flashcard app as a vocabulary learning tool can be a good consideration. Compared to a traditional paper-based flashcard, which was long proven to be an effective vocabulary learning tool, the mobile flashcard app creates more engaging and effective learning environment where the learners are provided with increasing, frequent exposure to target words, which leads to better outcomes in L2 vocabulary acquisition (Chen & Truscott, 2010). By utilizing the features of smartphones such as immediacy, accessibility, flexibility, and portability

(Song, 2008; Zhang et al., 2011), vocabulary learning can occur without time and place constraints; thus, it can effectively enhance learning experiences and promote learner's performance.

Second, when choosing the flashcard apps that are available on the app stores for vocabulary learning purposes, select the flashcard app that should present the vocabulary words effectively within a small screen of the mobile phone with its font auto-sizing function or the platforms in which the whole screen is used to show one word per page. In the previous studies, a small screen and discomfort of using keyboards were frequently reported as the disadvantageous features of using a mobile phone as a pedagogical tool. By carefully choosing the flashcard app which offers beneficial functions and features to present the words effectively, a small pocket-size of mobile phone can become a useful pedagogical tool for vocabulary learning and bring an effective learning outcome.

Third, teachers should consider giving learners appropriate reminder which calling learners' attention to vocabulary learning activities on the flashcard app and which making learning occur in a spaced repetition way, which is proven for effective vocabulary learning. Just creating learning opportunities is not adequate for teachers' role in this type of learning. It is of significant importance for teachers to encourage learners to pay attention to vocabulary learning on the mobile flashcard app and promote learning and engagement. It is recommended that teachers should give learners a reminder link to the flashcard app by using 'share' function and the frequency of sending a reminder to be twice or more a week.

However, this study has some limitations. The current research didn't examine how learners engage in vocabulary activities on the flashcard app; that is, the learners' actual use of the flashcard app for vocabulary learning such as how much time they devoted for studying target words using the flashcard app, how frequently they opened and used the flashcard app for learning and so on. As for future study, it would be recommendable to investigate how learners use their flashcard app to engage in their learning activities in order to better gain an in depth understanding and insight perspective on the topic of subject. One way of examining learners' behavior on mobile learning environment, using tracking mechanism such as WebCT's tracking system (Lu, 2008) is advisable to detect certain behaviors and usage patterns of learners on mobile phones. This kind of tracking mechanism is also found to be useful when instructors are monitoring learners' behavior and giving appropriate intervention and assistance (Hwu, 2003). In addition, a future study should consider using the visual support such as an image or a movie clip when making the flashcard app, which can maximize the beneficial features of using the flashcard app for vocabulary learning.

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APPENDIX A

A vocabulary list of 100 words used on a Flashcards app

1. ambitious	8. coincide	15. contemplate
2. promote	9. strategy	16. constant
3. scarce	10. arbitrary	17. exclusive
4. abundant	11. fancy	18. manipulate
5. efficient	12. concur	19. constitute
6. apparent	13. convey	20. measure
7. censure	14. vain	21. imply

22. confer
23. devise
24. productive
25. demonstrate
26. boast
27. boost
28. dwell
29. yield
30. wander
31. cumbersome
32. convention
33. maximize
34. compete
35. financial
36. corporate
37. reflect
38. furnish
39. mediocre
40. infer
41. temper
42. indigenous
43. integrate
44. interpret
45. advance
46. legitimate
47. flaw
48. fluctuate
49. intimate
50. satisfy
51. impair
52. humble
53. deposit
54. liberal
55. deceive
56. adequate
57. harsh
58. hasty
59. attitude
60. hesitate
61. merit
62. hindrance
63. degrade
64. exploit
65. expose
66. extract
67. feasible
68. aggregate
69. cease
70. cohesion
71. notion
72. distort
73. attribute
74. diverse
75. modest
76. credible
77. accurate
78. hectic
79. nonchalant
80. flourish
81. disgruntle
82. clumsy
83. implement
84. gravity
85. humiliate
86. frustrate
87. device
88. objective
89. adverse
90. foster
91. decay
92. bland
93. distribute
94. disconnect
95. hazardous
96. inflate
97. hierarchy
98. prospect
99. resolve
100. obligatory

APPENDIX B

Semi-structured interview questions (10 questions)

1. What are your general thoughts and experiences about using the flashcard app on the smartphone for vocabulary learning?
2. What do you like most when you used the flashcard app for vocabulary learning?
3. What do you dislike most when you used the flashcard app for vocabulary learning?
4. What are the advantages of using a flashcard app in the course?
5. What are the disadvantages of using a flashcard app for vocabulary learning in the course?
6. Do you think the use of the flashcard app helped you to develop vocabulary knowledge?
7. Was smartphone flashcard app an effective tool for learning vocabulary? Why or why not?

8. Are you interested in taking this type of classroom in the future? Why or why not?
9. What are the ways to improve these new learning experiences?
10. If you have any other opinions, please feel free to share with me.

Examples in: English
Applicable Language: English
Applicable Levels: Tertiary education

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