

Using Digital Flashcards to Enhance Thai EFL Primary School Students' Vocabulary Knowledge

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Abstract

There is growing evidence in L2 vocabulary research that digital flashcards facilitate learners' vocabulary learning and development. Several studies also suggest that deliberate vocabulary teaching is critical for successful language learning. Hence, the primary goal of this study was to investigate whether the use of digital flashcards could improve English vocabulary knowledge of the form-meaning link in Thai primary school children in an EFL context. The study also explored Thai primary school students' attitudes toward using digital flashcards in vocabulary learning. The participants were 120 Thai primary school students who were divided into experimental and control groups. The experimental participants were taught using digital flashcards, while the control group received no unique treatments. Four measures of vocabulary knowledge were used to assess the participants' vocabulary learning. A five-point Likert scale questionnaire was also used to explore the students' attitudes toward digital flashcards. Descriptive and inferential statistics were used to analyze the data. The results showed that although both cohorts significantly improved their receptive and productive knowledge of L2 vocabulary, the students in the experimental group performed significantly better than students in the control group. These results indicate that digital flashcards are an effective method to facilitate vocabulary learning in Thai primary school learners. The analysis of the questionnaires also showed that learners had a very positive attitude towards the use of digital flashcards. These findings reaffirm the efficacy and value of visual and sound images, such as digital flashcards, in vocabulary learning. Implications for practitioners and suggestions for further studies are also addressed.

Keywords: vocabulary knowledge, digital flashcard, intentional vocabulary learning

1. Introduction

1.1 Background of the Study

The English Academy of Office of the Basic Education Commission in Thailand (Office of The Basic Education Commission, Ministry of Education, 2016) states that primary school graduates should understand 1,050-1,200 English words. However, Thai primary learners do not possess that level of English vocabulary. Inadequate vocabulary knowledge remains the most significant problem for Thai English as a foreign language (EFL) learners (Tassana-ngam, 1994). In addition, according to the Ordinary Nation Education Test (ONET), grade six students had an average of 39.4%, indicating their inadequate English proficiency levels (The National Institute of Educational Testing Service Public Organization, 2021). There are several reasons for this low proficiency level, including insufficient English language exposure (Tassana-ngam, 2004) or learning only a single meaning of words (Wimolkasem, 1992). This problem is particularly evident in the Ordinary National Education Test (ONET English score of Grade Six learners), which shows that the average English score for grade six learners is lower than 50 (The National Institute of Educational Testing Service Public Organization, 2021).

Several studies have revealed the relationship between vocabulary bank and L2 reading and listening skills. Indeed, L2 learners cannot express their message clearly and meaningfully in speaking and in writing without adequate vocabulary knowledge (Anderson & Freebody, 1981; Bernhardt & Kamil, 1995; Durgunoglu, 1997;

Koda, 1989; Laufer, 1992; Nation, 2006; Nation & Laufer, 1995; Olinghouse & Leaird, 2009; Wilkinson, 2017). Vocabulary is, therefore, one of the most crucial aspects of any language, especially English, and is required for all four skills: listening, speaking, reading, and writing. Waring (1997, pp. 94-114) stated that “without grammar, little can be conveyed; without vocabulary, nothing can be conveyed”. In this regard, vocabulary is considered a mandatory aspect of language learning because it facilitates communication. Vocabulary knowledge is also essential for second or foreign language learners’ English language proficiency (Nation, 2013; Schmidt, 2010). However, acquiring vocabulary and gaining sufficient vocabulary knowledge can be an obstacle for some students due to several discerning factors, including learning disabilities and lack of exposure to English, self-confidence, and knowledge about proper vocabulary learning strategies (Yunus & Mohammad, 2016). Therefore, teachers and students have not been unsure of the best practice to learn vocabulary. In order to improve the vocabulary knowledge of L2 learners, teachers apply many teaching methods, such as dictionaries, visual materials such as pictures or real objects, songs, games, or flashcards. Such strategies also allow teachers to create opportunities to help students consolidate their vocabulary learning (Magnussen & Sukying, 2021; Sung, Chang, & McLaughlin, 2016).

1.2 Importance of Vocabulary Learning

Different learning strategies are used in second language acquisition depending on the task type and context. While direct vocabulary teaching strategies have long been used in language classrooms, the recent rapid growth in educational technology has stimulated the interest of vocabulary researchers.

1.3 Flashcard Vocabulary Learning

Flashcards are a set of double-sided cards designed for direct vocabulary learning that allow learners to practice recalling the form and meaning links via repeated retrieval of L2 words by flipping the front and back sides of the cards. Flashcards may vary in form, ranging from printed to digital versions or digital flashcards (DFs). Previous studies have shown that flashcards are effective learning tools and can enhance vocabulary knowledge for learners through the retrieval of spacing repetitions (Nation, 2013). Flashcards also appear to be more effective than other vocabulary learning techniques, regardless of their delivery form. For example, flashcards help students’ vocabulary growth (Nation, 2011) and can help students focus on both form and meaning (Komachali & Khodareza, 2012). However, the effects of digital flashcards on L2 vocabulary acquisition and development and the pedagogical implications of using flashcards have yet to be comprehensively investigated (Elgort, 2011; Hustjinm, 2003; Komachali & Khodareza, 2012; Nakata, 2011; Nation, 2013). Therefore, the present study investigates how digital flashcards can be integrated into intentional and direct learning tasks to enhance students’ vocabulary learning outcomes and experiences through a classroom-based experiment. In addition, this study focuses on the form-meaning link of vocabulary items mainly because the form and meaning knowledge is fundamental for mastering other components of vocabulary knowledge (Nation, 2013; Schmitt, 2010).

1.4 Purposes of the Study

This research focused on vocabulary instruction using digital flashcards. Specifically, it investigated the impact of digital flashcards on the form-meaning link of English vocabulary knowledge among grade six primary school children in a Thai EFL context. The study also explored Thai grade six primary school students’ attitudes toward using digital flashcards for vocabulary learning. Two research questions were formulated to guide the study:

- 1) To what extent do digital flashcards enhance Thai primary school students’ vocabulary knowledge?
- 2) What are Thai EFL grade six primary school students’ attitudes towards using digital flashcards in vocabulary learning?

2. Review Literature

Vocabulary knowledge is essential for language learners to comprehend others. There are three vocabulary knowledge components: form, meaning, and use. Knowledge of word form indicates the learner’s ability to notify the phonological and morphological components in spoken and written modes. Knowledge of word meaning describes the learner’s capability to understand the concepts and lexical networks informing and interpreting those words. Finally, knowledge of word use demonstrates the learner’s ability to position when and where those words can be used in authentic contexts. Table 1 shows Nation’s (2013, p. 49) list of the word knowledge framework.

Table 1. Aspects of word knowledge (Nation, 2013, p. 49)

Form	Spoken	R	What does the word sound like?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written and spelled?
	Word parts	R	What parts are recognizable in this word?
		P	What word parts are needed to express meaning?
Meaning	Form and meaning	R	What meaning does this word form signal?
		P	What word form can be used to express this meaning?
	Concepts and references	R	What is included in the concept?
		P	What items can the concept refer to?
	Associations	R	What other words does this word make us think of?
		P	What other words could we use instead of this one?
Use	Grammatical functions	R	In what patterns does the word occur?
		P	In what patterns must we use this word?
	Collocations	R	What words or types of word occur with this one?
		P	What words or types of words must we use with this one?
	Constraints on use	R	Where, when and how often would we meet this word?
		P	Where, when and how often can we use this word?

Note: R = receptive knowledge, P = productive knowledge

According to Nation (2013), the quality of vocabulary learning is conditional on the amount of learner involvement while processing individual words. He further explains three cognitive processes that lead to a word being learned. These processes comprise noticing through deliberate instruction, retrieval and creative (generative) use.

Table 2. Types of repetition of word meaning (Nation, 2013, p. 457)

Type of processing	Type of repetition
Noticing	Seeing the same word form and simultaneously presented meaning again
Retrieval	Recalling the meaning in different contexts requiring
Creative use	Recalling the meaning in different contexts requiring a different instantiation of the meaning

The noticing process involves a learner's attention to a given word and marks it as an unknown. This means that the learner needs to notice the word and be aware of it as a valuable lexical item. However, the learner realizes that the word is met before, but it is used differently. Besides, the learner will tend to decontextualize the word the moment they notice it, which, in turn, will provide the foundation for a better understanding of the word. The process of de-contextualization occurs either consciously or subconsciously in various ways. For example, it happens while listening or reading activities, when the teacher highlights a particular word while negotiating meaning in speaking tasks, or when the teacher explains the word, be it translation, giving a synonym, or target language definition.

While the noticing process directs the learner toward learning the word, the retrieval reinforces the word's meaning in the learner's mind. Nation (2012) suggested that the more frequent the retrieval of a particular lexical item in a learning process, the greater the chance that the item will strike more profound in the learner's memory. Therefore, repetition and retrieval of the word extend its meaning or definition, and repetitive exposure to and use of it will lead the learner to better understand each meaning of the word they encounter. However, the span of time between encounters cannot last that long. The most significant increase in learning occurs in two or three repetitions for reading, while the most significant growth occurs between five and six repetitions for listening (Vidal, 2011). Brown, Waring and Donkaewbua (2008) show that the word met more often had a greater chance

of being learned. Webb (2007) argues that gains over several aspects of word knowledge result from repetitions. Still, at least ten repetitions would be needed to develop a rich knowledge of several aspects of a word.

Finally, the process of creative use occurs when “previously met words are subsequently met or used in ways that differ from the previous meeting with the word” (Nation, 2013, p. 110). These new encounters push learners toward a reconceptualization of their knowledge of such words. For example, if a learner has met the word book used as a noun as in “We bought a book yesterday,” and then meets “We booked tickets for a football match, the learner will need to reconsider the meaning and uses of ‘book’. This phenomenon will help the learner establish the memory of this word. However, creative use is not restricted to the symbolic addition of word meaning. It can apply to a range of variations from inflections and derivations through collocation and grammatical context to reference and meaning (Nation, 2013).

Research on L2 vocabulary learning showed that deliberate vocabulary learning significantly outperformed the incidental group on vocabulary tests (Tabrizi & Feiz, 2016). Moreover, Elgort (2011) argued that deliberate vocabulary learning is more effective than incidental learning because the latter often requires long-term and extensive exposure to linguistic input. Besides, naturalistic language learning conditions are uncommon in English as a foreign language (EFL) or other foreign language learning contexts. By contrast, deliberate vocabulary learning enhances learners’ process of vocabulary development. This is due to the focused repetition or memorization strategies, which can be completed individually in a short period of time. Arguably, deliberate vocabulary learning retention rates are higher than those obtained with incidental learning (Hustijn, 2003), showing that deliberate attempts to learn vocabulary are effective and worth the effort. The research concludes that the direct and intentional learning method is a more effective way to learn and retain new words for L2 learners (Nation & Meara, 2010). Therefore, this study focused on a deliberate, direct learning method, namely digital flashcards, to enhance vocabulary learning in a Thai EFL context.

3. Research Methodology

This quasi-experimental research study examines whether using digital flashcards as a direct teaching method can improve grade six students’ vocabulary knowledge. A control group was taught using direct translation, the traditional method, while the experimental group was taught using digital flashcards. Both groups used the same English textbook, “Say Hello Grade Six.” The traditional teaching method for the control group involved a conventional method that used classroom tools such as English textbooks, notebooks, and printed materials. This method relies on teachers using direct teaching, and it is largely teacher-centred. Students could practice reviewing the words by looking in their notebooks and reviewing their textbooks at home. The teacher also conducted class activities such as worksheets and written, paper, and oral recitation tasks to better understand the level of the students.

The experimental group were taught using the digital flashcards method. Flashcards were prepared using Microsoft PowerPoint, and the teacher prepared a computer, monitor, LCD projector, speakers, and electronic tools such as smartphones or tablets inside the classroom. The teacher showed the words in English on the computer screen, broadcasted proper pronunciation of the word by turning on digital sound, and provided the meaning of the word in the Thai and English language. Students in the experimental group had to read the given words and spell them correctly. The teacher also conducted class activities such as an online worksheet, online quiz, and oral recitation to better understand the students’ level and comprehension.

The treatment period for both groups included eight 50-minute classes. All students completed the vocabulary checklist during the first week, weeks 2-9 were the teaching period, and in week ten, students completed the vocabulary post-test.

3.1 Research Design

The lesson plans used in this study were adapted from Gairns and Redman (1986). Each unit consisted of twenty target words, and the student's goal was to study an average of eight to twelve words in fifty minutes. A sample of the teaching lessons for the control and experimental groups is shown in Tables 3 and 4, respectively.

Table 3. Sample of a Traditional Teaching Lesson

Stage	Activities	Materials
Warm-up	1. The teacher presents the title of the subject that the students will learn. 2. The teacher encourages students to think about the meaning of the title and the related vocabulary.	
Presentation	1. Teacher provides the target wordlists with the Thai meaning and asks students to memorize the words. Then, the teacher asks students to explain the meaning of each word in Thai, and students have to read the word after the teacher.	Book
Practice	1. The target words are presented on the blackboard, and students repeat the word aloud twice. The words should also be written in their notebook. 2. The teacher will provide students with an assignment in the workbook. The teacher writes down the words on the blackboard and then asks the students to spell them.	Notebook Book
Production	1. Students practice the words individually in their notebooks by matching the words with the meaning in Thai.	Notebook
Wrap-up	The teacher reviews the meaning and form of the words.	

Table 4. Sample of Digital Flashcards Teaching Lesson

Stage	Activities	Materials
Warm-up	The teacher presents the title of the subject that the students will learn. The teacher encourages students to think about the meaning of the title and the related vocabulary.	
Presentation	The teacher explains the objectives of the lesson and assigns the student work using digital flashcards. Then, students complete the activity online. The teacher presents new vocabulary using digital flashcards, shows how to pronounce the vocabulary, and tells students to repeat.	Digital flashcards Computer/smartphone
Practice	The teacher presents the “Use Recall” activity to students and explains that the word and the definition are written on different slides. The teacher presents “Learn Receptively and Productively.” For receptive learning, the teacher shows the word and provides its meaning. For productive learning, the teacher will encourage the students to recall and retrieve the word and the meaning of each word by matching the word to the proper meaning. The teacher presents the “Changing the orders of cards” activity to students. The teacher presents the “Put the difficult words near the beginning” activity. The teacher presents the “Say the word aloud” activity to students. Students are shown the word meaning and have to say the associated word aloud.	Digital flashcards Computer/smartphone
Production	Students complete the online worksheet.	Digital flashcards Computer/smartphone
Wrap up	The teacher assigns students to write at least five words they have learned from digital flashcards.	Computer/smartphone

3.2 Participants

The participants were 120 grade six students of a public school in northeastern Thailand. The participants were divided into the control group (n = 60) and the experimental group (n = 60). All participants in this study were Thai English learners who had been learning English for nine years. The experimental group was taught with digital flashcards materials, whereas the control group was instructed with the grammar-translation method. Students learn grammatical rules and structures in the grammar-translation method and then apply them by

translating sentences between English (L2) and the native Thai language (L1). Both groups had a similar level of English proficiency, which was A1 level of CEFR.

3.3 Selecting Target Words

One hundred forty-six target words from the “Say Hello” number 6 for the sixth-grade textbook were selected and verified against the New General Service List (NGSL) to ensure that the words were suitable for the participants’ English proficiency levels. This English vocabulary checklist test was piloted with the control and experimental group participants to select the known and unknown words. The participants were given 50 minutes to finish the test. Table 5 shows an example of a checklist test. The top 80 unknown vocabulary items from the checklist test were used as the target words during the treatment.

Table 5. Examples of An English Vocabulary Checklist Test

Word	Known word	Unknown word	Meaning
beautiful			
capital			
forest			

3.4 Research Instruments

Four research instruments were used, including two tests of word form (written) and meaning (form-meaning) to measure receptive and productive dimensions and a questionnaire.

3.4.1 Receptive Word Meaning (L2 Translation Test)

The receptive word meaning test was designed and developed based on Nation and Belgar (2007; 1983; 1990) to measure receptive knowledge of the form-meaning aspect. Specifically, this test assessed the participants’ ability to provide word meaning. This test was designed in the form of fill-in-the-blank with 20 questions. One point was awarded for each correct answer, and no points were awarded for a blank or incorrect answer. An example from the receptive word meaning test is shown below:

Instructions: Look at the following description and choose the words with the correct meaning.	Point
Example: An area of knowledge that you study in a school subject	1

3.4.2 Productive Word Meaning (L1 Translation Test)

The productive test of meaning was adapted from Laufer and Goldstien (2004) to measure recall and knowledge of the form-meaning aspect. The test required participants to read the meaning of a word in Thai and rearrange the English letters to provide the associated English word. The test included 20 questions. One point was awarded for each correct word definition, and no points were awarded for a blank or incorrect word definition. Below is an example from the productive test of word meaning:

Instructions: Read the meaning of the following words in Thai (L1) and arrange the letters to form the correct words

Word Questions	Answer	L1 Meaning	Correct Answer	Point
1. p o o r a h p h e r g t	photographer	ช่างถ่ายภาพ	photographer	1
2. l e c e l e n x t	excelletn	ยอดเยี่ยม	excellent	0.75
3. a e r f u l c	careflu	ระมัดระวัง	careful	0.5
4. e e b t e w n	betewne	ระหว่าง	between	0.25
5. v g e e b t a l e	vebteael	ผัก	vegetable	0

* Based on Mann, Bushell Jr., & Morris (2010)

3.4.3 Receptive Word of Form Test

The receptive spelling test was adapted from Webb (2009) to assess the students’ ability to form or spell the words. This test was taken during the tenth week of treatment. It was designed in the form of matching test formats, which required learners to match the words with the picture and complete the spelling for each picture to measure students’ recognition of accurate spelling. There were 20 questions, and one point was awarded for each correct answer and no points were given for a blank or incorrect answer. Below is an example from the receptive word spelling test:

Instructions: Match the word with the picture, and complete the spelling	Point
1. <u>stretch</u>	1



3.4.4 Productive Word of Form Test

The productive vocabulary spelling test was adapted from Webb (2009) and was designed in the form of a fill-in-the-blank test, which required learners to write target words. The test measured the extent to which students could write the correct spelling of the target word. There were 20 questions. One point was awarded for each correct spelling, and no points were awarded for incorrect spelling. Minor spelling mistakes that did not change the meaning of the word were ignored. Below is an example from the productive test of word spelling:

Instructions: Complete each sentence and correctly write the word in the spaces provided	Point
1. I send a mes _ _ _ _ from my mobile phone.	
Students must fill message to get one point.	1
Students get no points for incorrect spelling. mesaeg	0

* Based on Mann, Bushell Jr., & Morris (2010)

3.4.5 Attitude Questionnaire

The questionnaire was used to explore the students' attitudes toward the use of digital flashcards (DFs) to enhance vocabulary knowledge, including the advantages and disadvantages of this method (Fredericks, Blumenfeld, & Paris, 2004). The questionnaires were written in Thai and English to avoid misunderstanding or confusion. All of the questions were closed-ended to ensure a quantitative perception for each participant. Questionnaires were given to the experimental group only and were administered after the completion of the immediate vocabulary post-test. The questionnaire consisted of two parts. The first part included questions related to the students' background information, and the second part included questions on the students' attitudes towards the use of digital flashcards. There were 15 items, and students had 30 minutes to complete the questionnaire. Students were asked to rate their views towards the DFs according to a 5-point Likert scale: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. The results of the questionnaire were interpreted with the following range: 4.50-5.00 (very high), 3.50-4.49 (High), 2.50-3.49 (moderate), 1.50--2.49 (low), and 1.00-1.49 (very low).

3.5 Data Collection

3.5.1 Choosing a Word to Learn

Choosing words to learn was the first step in the flashcard strategy. Learning useful words was the priority when making digital flashcards. As such, the words should be high-frequency words that fulfil language use needs. Teachers should avoid interference by separating similar words, same lexical sets, and synonyms to ensure that learners are not confused (Waring, 1997).

3.5.2 Making Digital Flashcards

Microsoft PowerPoint was used to create the digital flashcards and present each word. Each word had two slides. The first slide was a word and picture, if possible. Nakata (2010) found that images improve learning, and others have also reported that L1 learning is faster in young learners if pictures are used. The second slide included English words and the meaning of the words in Thai, as previous research has shown that learning is more effective if the meaning is translated into the first language (Laufer, 1997). The flashcards were kept simple yet interesting by using animation and sound effects. The words were arranged from difficult to easy to ensure the learners paid attention (Baddeley, 1990).

3.5.3 Using Digital Flashcards

Using the digital flashcard was the final step of the flashcard strategy. Digital flashcards were used for retrieval by allowing learners to recall the meaning of the word from their memory when the second language word was presented on one side of the flashcard Alnajjar M. & Brick B. (2017). Flashcards should be used repetitively because one exposure is not sufficient for L2 learners to gain vocabulary knowledge of that word (Nation, 2013). Students were provided with the following guidelines for using the flashcards: (1) retrieve rather than recognize, (2) learn only 15 to 20 words at a time, (3) space the repetitions, (4) repeat the words aloud to absorb into long-term memory, (5) use the depth processing technique, (6) avoid interference, (7) keep changing the order of

the words in the pack, and (8) use context and collocating words Baleghizadeh, S., & Ashoori, A. (2011). Putting known words aside and concentrating on difficult words can also help learners retain the meaning of difficult or unknown words (Hung, 2015).

The control group was taught using the traditional teaching method, and the teacher used books, papers, and printed materials during the treatment. Both experimental and control groups were taught the same topic during the eight-week teaching period.

3.5.4 Data Collection Procedure

The data collection procedure was completed over twelve teaching periods. A vocabulary checklist test was given to both experimental and control groups in the first week. This test included 146 words based on the school textbook, *Say Hello Grade Six*. Participants had 60 minutes to mark their unknown words. The student had to check (✓) if they knew the word and write its meaning to answer the checklist test. The participants were asked to mark a cross (×) if the given word was unknown. Based on the vocabulary checklist test results, 80 words that were the most unknown to the students were identified as the vocabulary to be taught during the experimental period.

Regarding the test administration, the productive tests of vocabulary knowledge were administered first, followed by the receptive tests of vocabulary knowledge. The productive measures of vocabulary knowledge were given first to avoid the possibility of drawing a connection between familiar words in the receptive vocabulary knowledge and their spellings and meanings in the productive vocabulary knowledge tasks. A 15-minute break was provided between the productive and receptive tests to reduce participants' fatigue. Before the tests were administered, the instructions and a few examples of the tests were provided to all participants in their native Thai language. The same tests were administered again in the same order after the experiment had been completed. The survey questionnaires were also administered to the participants in the experimental group at the end of the teaching period to assess their attitudes towards the deliberate vocabulary teaching approach using the digital flashcards.

3.6 Data Analysis

The descriptive statistics, including mean (\bar{X}), and standard deviation (S.D.) in the Statistical Package for the Social Science (SPSS) program, were employed in the analysis of quantifying the questionnaire data with a significant level of 0.05. For the four tests, the scores for each test were analyzed by descriptive statistics, including mean (\bar{X}), standard deviation (S.D.), and percentile in the Statistical Package for the Social Science (SPSS) program. After that, inferential statistics, namely, *t*-test analysis, was used to analyze whether test scores were statistically significant.

4. Results

4.1 To What Extent Do Digital Flashcards Enhance Thai Primary School Students' Vocabulary Knowledge

Table 6 summarises the students' overall performance on the receptive word meaning (L2 Translation Test) that both experimental and control groups scored higher at the end of the experiment. This indicated that the pedagogical methods could improve receptive and productive Thai primary school participants' vocabulary knowledge. In addition, the dependent-samples *t*-test analysis also revealed a significant difference in within-group (pretest and posttest) performance. Notably, the experimental participants' scores were higher than their counterparts' scores. The independent-samples *t*-test was also conducted to determine the difference between groups. The analysis of the findings indicated no significant difference between both groups' overall pre-test performance. However, although both groups performed better on the posttests, the statistical analysis revealed a significant difference between their posttest scores, suggesting that word part strategies are more effective.

The quantitative data analysis revealed that the experimental group outperformed the control group in all vocabulary knowledge tests, as shown in Tables 6-9. Table 6 shows the results from the L2 translation test. Overall, the experimental group scored 66.25% on the post-test, while control participants scored only 55%. An independent *t*-test indicated that the post-test scores were significantly different ($t = 17.38$, $p = 0.000$), showing that the improvement in receptive word meaning was greater for experimental group participants than for the control group.

Table 6. Students' overall performance on the receptive word meaning (L2 Translation Test)

Group	N	Pretest			Post-test			t-test	p-value
		Mean	%	S.D.	Mean	%	S.D.		
Experimental	60	9.5	47.50%	0.68	13.25	66.25%	0.78	11.33	0.000*
Control	60	9.5	47.50%	0.71	11.00	55.00%	0.63	5.61	0.001*
t-test		0.000			17.38				
p-value		1.000			0.000				

Note. *Significant at the 0.05 level ($p < 0.05$)

Table 7 shows the scores on the test of receptive word form. The results revealed that the experimental group scored 61.25% on the post-test, but the control group scored 51.25%. An independent *t*-test indicated that this difference was statistically significant ($t = 12.74$, $p = 0.000$).

Table 7. Students' overall performance on the receptive word form (vocabulary knowledge of spelling)

Group	N	Pretest			Post-test			t-test	p-value
		Mean	%	S.D.	Mean	%	S.D.		
Experimental	60	9.75	48.75%	0.74	12.25	61.25%	0.98	7.88	0.000*
Control	60	9.5	47.50%	0.66	10.25	51.25%	0.72	6.34	0.01*
t-test		1.95			12.74				
p-value		0.053			0.000				

Note. *Significant at the 0.05 level ($p < 0.05$)

Table 8 illustrates the results from the test of productive word meaning. The average post-test score for the experimental group was 60.25%, while the control group scored 53.75%. A *t*-test revealed that the experimental group's score was significantly higher than the control group ($t = 15.93$, $p = 0.000$).

Table 8. Students' overall performance on the productive word meaning (L1 Translation Test)

Group	N	Pre-test			Post-test			t-test	p-value
		Mean	%	S.D.	Mean	%	S.D.		
Experimental	60	8.75	43.75%	0.74	13.25	60.25%	0.71	7.88	0.001*
Control	60	8.50	42.50%	0.66	11.00	53.75%	0.66	6.34	0.049*
t-test		1.95			15.93				
p-value		0.053			0.000				

Note. *Significant at the 0.05 level ($p < 0.05$)

Table 9 shows scores on the test of productive word meaning. The average post-test score for the experimental group was 58.75%, and the control group's average score was 51.25%. An independent *t*-test revealed that the experimental group's post-test score was significantly higher than the control group's score ($t = 9.25$, $p = 0.000$).

Table 9. Students' overall performance on the productive word form (vocabulary knowledge of spelling)

Group	N	Pretest			Post-test			t-test	p-value
		Mean	%	S.D.	Mean	%	S.D.		
Experimental	60	9.00	45.00%	0.91	11.75	58.75%	0.98	10.55	0.001*
Control	60	8.75	43.75%	0.72	10.25	51.25%	0.72	7.35	0.05*
t-test		1.67			9.25				
p-value		0.0098			0.000				

Note. *Significant at the 0.05 level ($p < 0.05$)

Table 10 summarises the results from the tests. Overall, this study demonstrates that the use of digital flashcards enhanced vocabulary knowledge among Thai primary school students. The quantitative data analysis revealed that the experimental group's post-test scores outperformed the control group's means in all vocabulary knowledge tests. Moreover, the current findings showed that Thai primary school participants acquired word

form-meaning (L2TT) before word-form-spelling (vocabulary spelling), as seen from the higher mean score of receptive and productive word meaning than those of receptive and productive word form.

Table 10. Summary of the pretest and posttest performance on all tests

Group		Receptive word meaning		Productive word meaning		Receptive word form		Productive word form	
		Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest
Experimental	Mean	9.50	13.25	8.75	13.25	9.75	12.25	9.00	11.75
	S.D.	0.68	0.78	0.74	0.71	0.74	0.98	0.91	0.98
	%	47.50%	62.25%	43.75%	60.25%	48.75%	61.25%	45.00%	58.75%
Control	Mean	9.50	11.00	8.50	11.00	9.50	10.25	8.75	10.25
	S.D.	0.71	0.63	0.66	0.65	0.66	0.72	0.72	0.72
	%	47.50%	55.00%	42.50%	53.75%	47.50%	51.25%	43.75	51.25%
t-value		0.00	17.38	1.95	12.74	1.95	15.93	1.67	9.25
p-value		1.000	0.000	0.053	0.000	0.053	0.000	0.098	0.000

4.2 What are Thai EFL Grade Six Primary School Students' Attitudes Towards Using Digital Flashcards in Vocabulary Learning

The questionnaire was used to explore the students' perceptions of the use of digital flashcards to enhance vocabulary knowledge. The results from the questionnaire are shown in Table 9. Participants' overall attitude toward using digital flashcards in vocabulary learning was very positive (4.52), suggesting that the participants enjoyed studying with digital flashcards and believed that digital flashcards were an effective instrument for studying English vocabulary. A score of 5 indicated that the students strongly agreed with the statement, whereas a score of 1 indicated that students strongly disagreed. As shown in Table 9, 10 statements had a very high mean score between 4.35 and 4.78, and the remaining five had a high mean score between 4.25 and 4.33. The highest mean score was 4.78, obtained by statement 1 (*I enjoy learning vocabulary through digital flashcards from electronic devices*). This shows that the students enjoy using digital flashcards and are more interested in learning when these electronic devices are used. This highest score is followed by the score of statement 2 (*I think digital flashcards assist me in recognizing the meanings of the words*), which shows that students agree that the digital flashcard teaching helps them improve their vocabulary knowledge. Statement 4 (*Using digital flashcards helped me to improve my recognition and recall of words*) was rated 4.71, suggesting that digital flashcards play an important role in making students recall and recognize the learned words.

The lowest mean score was 4.25, obtained by statement 15 (*I feel that learning vocabulary by categorizing words into themes would help me recognize words faster easily*), followed by statement 14, which scored 4.26 (*Using digital flashcards allow me to learn new vocabulary*). This indicates that some students did not feel that the digital flashcard intervention enhanced their learning.

In summary, the current findings indicate that eight weeks of digital flashcards intervention improved the students' vocabulary knowledge. Furthermore, most participants were satisfied with the digital flashcards intervention as it helped them learn new vocabulary and enhance their vocabulary knowledge.

Table 11. Analysis of the questionnaire on students' attitudes

No.	Items	X	S.D.	%	Meaning
1	I enjoy learning vocabulary through digital flashcards from electronic devices.	4.78	0.65	95.62%	Very high
2	I think digital flashcards assist me in recognizing the meanings of the words.	4.77	0.74	95.51%	Very high
3	I think using digital flashcards is a good way to learn vocabulary.	4.73	0.63	94.52%	Very high
4	Using digital flashcards helped me to improve my recognition and recall of words.	4.71	0.78	94.25%	Very high
5	I enjoy using digital flashcards to learn vocabulary.	4.66	0.87	93.14%	Very high
6	I think digital flashcards guide me to spell the words.	4.65	0.67	93.12%	Very high
7	I feel comfortable when I use digital flashcards to learn vocabulary.	4.58	0.79	91.56%	Very high
8	Digital flashcards are appropriate for learning vocabulary at my level.	4.56	0.73	91.14%	Very high
9	I think digital flashcards facilitate me in becoming familiar with words.	4.45	0.54	89.03%	Very high
10	I feel motivated when I use digital flashcards to learn spelling and meaning.	4.42	0.72	88.31%	Very high
11	I think the pictures from digital flashcards assist me in recalling the words.	4.34	0.44	86.83%	High
12	I think the pictures in digital flashcards enable me to recall the words.	4.33	0.69	86.63%	High
13	I feel much better when I use digital flashcards to learn spelling and meaning.	4.33	0.66	86.58%	High
14	Using digital flashcards allows me to learn new vocabulary.	4.26	0.68	85.15%	High
15	I feel that learning vocabulary by categorizing words into themes would help me recognize words faster and more efficiently.	4.25	0.71	85.03%	High
Total		4.52	0.52	90.43%	Very high

5. Conclusion

In response to Research Question 1 (To what extent do digital flashcards enhance Thai primary school students' vocabulary knowledge?), the quantitative data obtained from four receptive and productive vocabulary skills tests were analyzed. The analysis of the current findings revealed the significant effects of digital flashcards on vocabulary knowledge among Thai primary school students. Specifically, primary school participants' vocabulary knowledge measured by three different tests significantly increased. However, in both cohorts of participants' word knowledge increase, the experimental participants' gain is substantially higher than their control peers. These findings suggest the benefits of digital flashcards in enhancing vocabulary learning.

In response to Research Question 2 (What are Thai EFL grade six primary school students' attitudes towards using digital flashcards in vocabulary learning?), on average, primary school students have a high level of satisfaction with digital flashcards concerning rote vocabulary learning. The current findings showed that the positive attitudes toward deliberate vocabulary learning through the digital flashcard could be due to its simplistic features, easy to make, and convenient to use or change according to the current context. Although flashcard learning is decontextualizing, flashcards are an effective mechanism for vocabulary learning and can provide vocabulary knowledge to learners through retrieval of spacing repetitions. Another explanation for the high satisfaction of digital flashcards could be because flashcards quickly speed up vocabulary knowledge for students. Furthermore, flashcards could boost learners' memory.

6. Discussion

The current findings revealed that using digital flashcards improved vocabulary knowledge among Thai primary school students. Specifically, while participants in both the control and experimental groups performed better on the post-test than the pre-test, the experimental participants performed significantly better than their control peers. These findings indicate that digital flashcards enhance vocabulary learning, and these results align with previous studies that digital flashcards benefit vocabulary learning processes (Nakata, 2011).

Digital flashcards are effective because they rely on intentional vocabulary learning. Deliberate vocabulary learning facilitates the acquisition process due to focused repetition and/or memorization strategies, and these strategies can be completed individually in a short period of time. Indeed, the gain in knowledge of the form and meaning of the target words could be explained by the deliberate learning of vocabulary input that allows learners to practice form-to-meaning and meaning-to-form recall in repeated retrieval of the target words. The directed conscious vocabulary learning through the digital flashcards will enable students to better remember and recall L2 vocabulary. The current results also suggest that deliberate attempts to learn vocabulary are effective and worth the effort.

The significant gain in vocabulary knowledge could also be explained by the cognitive processes of noticing and retrieval. Noticing refers to the learner's attention to the target L2 word and directs or leads to L2 words being learned. By contrast, retrieval reinforces the meaning of the individual word in the learner's mind. Schmidt's (2010) noticing hypothesis states that seeing is the necessary condition for L2 vocabulary learning. When using digital flashcards, primary school participants must consciously notice L2 features or characteristics of the target words and pay deliberate attention to form-meaning links of lexical items to optimize their learning. For these reasons, vocabulary is commonly taught explicitly and directly in foreign language classrooms to compensate for the limited exposure and resources that may otherwise be available. This suggests that the more frequent the retrieval of the particular lexical item in a learning process, the greater the likelihood that the learner will acquire the target word. Indeed, these new encounters push learners toward a reconceptualization of their knowledge of such words, which helps the students establish their memory of this word.

The present findings are consistent with previous studies arguing that deliberate vocabulary learning through word cards or digital flashcards is very effective (Hung, 2015; Magnussen & Sukying, 2021; Nation, 2011). Indeed, several studies have confirmed that deliberate vocabulary learning is more effective than incidental learning (Nation, 2010). Hence, the current results are consistent with previous studies that repetition and retrieval of the L2 word extend its meaning or definition, and repetitive exposure and use will lead to a better understanding of the word's meaning (Elgort, 2011; Hung, 2015; Hustijn, 2003; Kerdmuenwai, 2018; Magnussen & Sukying, 2021; Nation, 2013). To conclude, the current study provides further evidence for the efficacy of digital flashcards in vocabulary learning and teaching.

6.1 Thai EFL Primary School Students' Attitudes Towards Digital Flashcards

Primary school students reported a high level of satisfaction with digital flashcards in relation to rote vocabulary learning. The current findings showed that the positive attitudes towards deliberate vocabulary learning via digital flashcards could be due to its simplistic features. Although flashcard learning is decontextualizing, flashcards are an effective mechanism for vocabulary learning and can provide vocabulary knowledge to learners through retrieval of spacing repetitions. Flashcards also lead to quick improvements in vocabulary knowledge and memory, which may explain the student's high satisfaction. The current findings are consistent with previous studies showing that flashcards facilitate learners focusing on form and meaning to retrieve vocabulary items (Magnussen & Sukying, 2021; Yuksel et al., 2020; Wilkinson, 2017).

Overall, the benefits of digital flashcards in accelerating deliberate vocabulary learning among Thai primary school students could be due to their efficacy, ubiquity, and entertainment value. The flashcards include visual images and sounds, which could motivate students to learn the meaning and spelling of individual words. In addition, flashcards could assist students in memorizing and recalling vocabulary items more effectively. The current findings provide support to the existing literature that digital flashcards are an effective tool for deliberate vocabulary learning (Nation, 2013; Waring, 2008).

7. Implications for Vocabulary Learning

The current study has yielded several important implications. First, since vocabulary is an essential component of language learning, practitioners need to equip themselves with up-to-date technological approaches. Specifically, the current study may be useful for language teachers and practitioners at all education levels, including syllabus planners, material developers, and test developers. In addition, the current findings can inform guidelines for learning language skills and sub-skills, including listening, speaking, pronunciation, vocabulary and grammar. Importantly, this study provides empirical evidence for the effectiveness of digital flashcards in facilitating vocabulary learning and teaching.

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