Technology-Enhanced Strategy Use for Second Language Vocabulary Acquisition

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Abstract

Research interest in second or foreign language (L2 or FL) vocabulary learning has been extended to encompass the field of computer-assisted language learning (CALL) in an attempt to improve competence in communication. In this study, a technology-enhanced strategy use (TESU) system was designed to engage L2 learners in the deeper processing of vocabulary while learning new lexical items. TESU enables learners to employ a range of available vocabulary learning strategies (e.g., keyword strategy), as well as e-tools (e.g., drawing and mind mapping) provided in the TESU system to practice English vocabulary outside of the classroom. The purpose of this study was to examine the impact of the prototype TESU system on the young learners' vocabulary gain. Two intact classes of 47 sixth graders were randomly assigned as the experimental and control groups. The instruments used included an online vocabulary pre-test administered prior to the treatments, and an online vocabulary post-test as well as a written recall test following the treatments. The preliminary results derived from the Independent-samples t-test indicated that the experimental group performed better than the control group in terms of vocabulary gain as the post-test and the vocabulary written recall reached a level of significance (p < .05). The findings also demonstrate the feasibility of utilizing the TESU system to learn new vocabulary and to collect data concerning the learners' vocabulary strategy use. Furthermore, this study provides evidence that the TESU system can encourage students to practice some useful but infrequently-employed strategies (e.g., the mnemonic keyword method).

Key Words: technology-enhanced strategy use, English as a foreign or second language, vocabulary learning strategy use

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INTRODUCTION

Vocabulary knowledge plays a crucial role in the receptive and productive skills associated with effective communication (Nyikos & Fan, 2007; Takeuchi, 2003). Without sufficient vocabulary knowledge, learners will experience communication breakdowns or comprehension difficulties when confronted with unknown words or expressions while conversing with native speakers of the language or while reading in the language. The way L2 learners gain lexical knowledge in order to facilitate effective communication or comprehension has attracted attention from scholars and researchers, including Nation (1990), Gu and Johnson (1996), Nagy (1997), Schmitt and McCarthy (1997), Lengkanawati (2004), Hiebert and Kamil (2005), Sagarra and Alba (2006), and Takač (2008). L2 vocabulary learning research has been increasingly evolving from conventional face-to-face classrooms into CALL, e.g., Stockwell (2007), DeHaan, Reed, and Kuwada (2010), and Gorjian, Moosavinia, Kavari, Asgari, and Hydarei (2011). However, most of the previous computer- or technology-related vocabulary research, especially for hypermedia, has focused on vocabulary learning via repeated exposure to reading or listening texts to promote incidental learning rather than through employing memory techniques, such as keyword methods or associating with an individual's previous knowledge, both of which engage learners in deep learning processing (Godwin-Jones, 2010). Thus, such memory strategies employing CALL technology that L2 learners use to enhance vocabulary learning remains little understood. Additionally, previous vocabulary research has focused on L2 adult and young adult learners rather than elementary-school students (Parker, 2008). The current investigation examines the young EFL learners' use of vocabulary memory strategies via a technology-enhanced strategy system outside of the classroom.

Issues relevant to L2 vocabulary acquisition are discussed in order to provide a link between the designed strategy use system and vocabulary learning theories. More specifically, these issues relate to the underlying theories of L2 vocabulary learning strategies, including definitions and types of vocabulary strategy use which has informed the prototyped design of the TESU system developed in this current study, as well as relevant research in L2 vocabulary acquisition in both CALL and non-CALL settings. The discussion is followed by the introduction of the TESU system. Finally, a study conducted to examine the effect of the system on the EFL young learners' vocabulary gain is reported along with pedagogical implications. This paper concludes with suggestions to improve the system.

LITERATURE REVIEW

Language learning strategy use, rooted in cognitive psychology and concerned with how people perceive, learn, remember, and think about information (Sternberg, 2009), refers to "specific actions taken by a learner to make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferable to new situations" (Oxford, 1990, p. 8). Strategy use that a learner employs to improve performance is conscious and observable (Anderson, 2005), which involves learners making decisions on what or how to learn and taking control of the learning (Garrison, 1997). The conscious actions taken by an L2 learner in order to improve word knowledge can be divided into two means—contextualized and decontextualized. The former strategies, used by the individual during listening or reading a text, allow the learner to guess or infer new word meaning from context (O'Malley & Chamot, 1990; Oxford, 1990). Such a view is commonly held in L1 acquisition where children acquire word knowledge in the native language through reading extensively and incidentally (Sternberg, 2009). In contrast, the decontextualized or mnemonic strategy use is what the learner employs to associate new words with his or her L1, existing knowledge and personal meaning (Oxford, 1990; Schmitt, 2000). In particular, making meaningful associations entails "deep processing in elaborate longer lasting and memory traces" (Craik & Lockhart, 1972). That is, when a learner analyses for meaning, the learner may think of other related associations, images, and experiences that make the input more meaningful and elaborate, enabling the learner to retain the input in memory.

Both contextualized and decontextualized approaches to vocabulary acquisition have been empirically examined in both L1 and L2 and in both CALL and non-CALL settings with an attempt to determine what strategies are likely to be used by individuals or to help learners to retain new words. For instance, in a non-CALL setting Gu and Johnson (1996) reported that EFL participants preferred using a rehearsal strategy rather than an inference strategy. Similarly, Lawson and Hogben (1996) found that the majority of participants utilized rehearsal strategies, repeating a target word or its meaning verbally or by repeatedly writing the word. Also, in some studies, findings describe the use of rote memorization techniques rather than mnemonics related to individual differences, for example age and length of time spent on L2 learning. An example of these studies is Cohen and Aphek (1980), where the results revealed that novice learners of L2 tended to employ rote repetition and suggested the mnemonic association techniques

were more effective than rote repetition methods to recall target words. In another example, Gu (2003) found that Asian students preferred using rote memorization strategies.

In CALL-based settings, research in L2 vocabulary acquisition has mainly investigated incidental learning using multimedia resources, such as Al-Seghayer (2001). Gorjian et al. (2011) examined the effects of multimodal annotations (e.g., CDs and dictionary software) on different proficiency levels of students in terms of both immediate and delayed retention and recall of vocabulary. The findings indicated that there was a significant difference in the growth of vocabulary knowledge between the two levels of the participants. The high achievers were able to recall or to retain more lexical items than were the low achievers and the former benefited from using CALL to increase their vocabulary knowledge. Likewise, Jones (2004) found that those who accessed the pictorial and written multimedia resources outperformed those who did not have access to the system in the immediate and delayed vocabulary tests. In addition, use of an online annotated system was observed to promote learners' critical thinking and both writing and literacy skills (Mendenhall & Johnson, 2010). The online annotated system improved learners' comprehension (Razon, Turner, Johnson, Arsal, & Tenenbaum, 2012) and was conducive to learning vocabulary and terminology terms (Chun & Payne, as cited in Glover, Xu, & Hardaker, 2007).

From the above studies, the computer- or technology-based devices enable learners to deploy vocabulary strategy use to achieve the depth of learning processes necessary for vocabulary retention or gain in the target language. This entails the relationship between the deployment of vocabulary strategy use and L2 vocabulary acquisition. Loucky (2006), and Gallo-Crail and Zerwekh (2002), for example, found that word gain relates to vocabulary strategy use, in that more successful learners who have a higher level of vocabulary retention employ a wider range of vocabulary strategies than those who use fewer strategies, such as guessing meaning from context. Ma and Kelly (2006) found that strategies requiring more mental effort were less frequently used, such as word grouping and mnemonics, whereas strategies like rote memorization were more frequently used. Such findings corroborate other studies conducted in a face-to-face environment, such as Lawson and Hogben (1996).

However, a number of issues have been raised from L2 vocabulary acquisition research. First, although many commercial multimedia resources provide better linguistic input and are more accessible than paper-based texts (Zhao & Lai, 2008), such resources often lack a pedagogical basis, such as taking into account learner needs (Ma &

Kelly, 2006). Hence, individualized technology is needed to encompass the complexity of L2 learning in order to cater to what learners need and to help them regulate vocabulary learning. Learners have different purposes or preferences for learning the target language and they also learn at a different pace from others (Zhao & Lai, 2008). Contemporary technology should thus take individual differences into consideration in order to facilitate effective learning in L2. In an Internet-based study, Horst, Cobb, and Nicolae (2005) explored the effectiveness of on-line individualized resources (www.lextutor.ca), such as concordance, dictionary, and cloze-builder, on L2 vocabulary retention. The results of the experiment demonstrated the interactive on-line vocabulary activities offered rich input and encouraged deeper processing. In a mobile-phone learning context, Stockwell (2007) assessed the use of a mobile-based intelligent vocabulary tutor system which allowed learners to access the language learning activities. However, there are no other technological resources available to assist regulating learners' memorization strategy use, nor is there any vocabulary CALL research conducted to examine strategy use by young learners. Together, the advent of the technological device was designed in the current study, entitled technology-based strategy use, which integrates multiple aspects of SLA theories as discussed elsewhere in this paper in order not only to make it feasible to observe the relationship between the individual's internal strategic processing and the attainment of L2, but also to make it an important resource for long-term learning.

Second, it is assumed that learning L2 vocabulary in context is more meaningful and accurate than learning a list of words out of context, in terms of vocabulary grammatical usage, such as collocations (Oxford & Scarcella, 1994). Such an approach requires learners to read texts extensively or to read often in order to encounter words used infrequently. If a high percentage of unknown words or words used infrequently appear in a reading or listening passage, it will be very difficult for an L2 learner to infer new word meaning from context (Schmitt, 2000).

Third, as far as L2 language strategy use is concerned, individual differences influence how learners process linguistic input. Particular groups of learners are also likely to employ certain types of strategies, given that the employment of strategies per se is embedded in a given cultural context as learners are "encultured" through classroom activities or the modelling of the teacher or their counterparts (Oxford, 1996). Similarly, strategy use also relates to the proficiency levels of students (Lawson & Hogben, 1996), with more proficient students possibly employing language learning strategies differently from less

proficient students. Strategy use further relates to other factors, such as age and personal preference (Oxford, 1990). Sagarra and Alba (2006, p. 228) state that "… L2 learners favour strategies that require minimum depth of processing, unless instructed otherwise," which not only points out the preference of L2 learners to use less effort to process the linguistic stimuli, but also implies that employing deeper processing strategies requires mediation. Where the teacher instructs L2 learners to use strategies like keyword mnemonics, learners are likely to do so. Sagarra and Alba (2006) examined the effectiveness of the strategy use for word retention and found that strategies like the keyword method were more effective than the rote memorization for word retention because the former type required more mental effort than the latter.

The afore-mentioned issues underlie the assumptions formulated in this study that the young participants as novice EFL learners are likely to learn what has been taught within the classroom, including vocabulary strategy use, and that in turn will influence how students learn new English vocabulary outside of the classroom when using the TESU system. This study thus aims to explore the relationship between English vocabulary knowledge and vocabulary strategy use by young EFL learners when using the vocabulary learning system. This study attempts to answer the following research questions: (1) What effect size explains the difference in the pre- and post-test scores between the groups? (2) To what extent can the types of vocabulary strategy use by the experimental group be identified through using the TESU system? (3) What effect size explains the difference in vocabulary written recall between the groups?

TESU VOCABULARY STRATEGY USE SYSTEM

The TESU system provided learners a list of vocabulary strategies as well as a wide range of e-tools to help the learners acquire new vocabulary in the target language. The learners could access the system through the Internet on a laptop, desktop or mobile phone. This system had two main interfaces: the learner interface allowed the participants to access the learning materials (320 must-learn vocabulary words as discussed in the Method section), and the teacher interface recorded the data, including the frequencies and types of strategy use and e-tools. Initially, the learners created the learning schedule and then started to learn the given vocabulary words on a daily basis by using the strategies as well as the e-tools. The introduction of the system and the adoption of the existing taxonomies of L2 vocabulary strategy use will be discussed in more detail in the subsequent paragraphs.

A list of vocabulary strategies was built into the TESU system, adapted from Oxford (1990) and O'Mally and Chamot (1990), and shown in Table 1. Of these, strategies such as "practice" involving silent or written repetition reviewing target items in intervals (e.g., few hours or days), which could possibly become automatic (Oxford, 1990, p. 42), are frequently employed by those who learn an L2 in the early stage (Nyikos & Fan, 2007). Rote memorization has proved to be effective for remembering new words in a short time. In contrast, mnemonic strategies like "keyword," "contextualization," and "analysis" involve a cognitive process, creating a visual image or story for the new words in L2 in order to remember them (Cohen & Aphek, 1981).

To illustrate the learner interface, Figure 1 in Chinese, was used to create a learner's profile; each individual student was given an account number and password to gain access to this system. In Figure 1, the student's name and last login date and time are shown in the upper box; the menu is displayed in the lower box on the left hand side of the screen and contains several options, e.g., "my learning log," each of which has different functions. In "my learning log" in Figure 2, for example, a monthly generated calendar page records learning progress, which permits a learner to plan his or her learning of words and to remind them what words need to be learned.

In Figure 2, if an individual forgot to learn the scheduled words on that day, a "crying face" would appear on the following day, indicating that the student was lagging behind what the student planned to learn. However, if the individual learned the scheduled words and employed any type of strategies, a smiling face would be displayed.

Two important features in the learner interface were the types of strategies and the tools. There were twelve types of strategies appropriate for vocabulary learning, as discussed in the preceding section; on the top of the grey area in Figure 3 are "practice," "note-taking," "keyword," "contextualization," "grouping," "imagery," "recombination," "deduction," "analysis," "physical response," "translation," and "transfer."

Twelve types of strategies, shown in Figure 3, were available for a learner to select from when learning the word "lion." The individual chose the note-taking strategy accompanied by the e-tool options shown below including a sound recorder, note-pad and video/audio uploader that allowed him or her to choose the available e-tools according to the learner's preferences. When the learner, for instance, preferred to use video resources to learn new vocabulary in relation to "skiing" and "skateboarding," s/he could use YouTube downloader to save the videos in the system. Alternatively, if the learner preferred using

Table 1
A List of Strategies Built in TESU

| Type	Description
Practice	Write or say newly learned words repeatedly in order to remember them.
Note-taking	Write learned words, such as the meaning, prefix, or suffix of a word, etc.
Keyword	Use the sound of a word in English in association with a word in Chinese, or use the sound to make meaningful associations.
Contextualization	Use a set of new words to create a situation or make a funny story in order to remember the words.
Grouping	Group words that involve the same or similar characteristics, words like "computer," "draw," "flower," "girl," "sing," "boy," "students," "classroom," "walk" to be divided into a group of verbal words ("draw," "sing," "walk") and a group of noun words ("computer," "boy," "students," "classroom").
Imagery	Use some words to create a mental image or describe ideas or situations.
Recombination	Combine a known word with a new word or vice versa to become another word, e.g., if the word "man" has been learned, a new word "super" or "door" along with "man" become "superman" or "doorman."
Deduction	Use a set of grammatical rules like the prefix "un" meaning "not" to infer meaning.
Analysis	Examine a word and break it down into morphemes, such as the word "speechlessness" that consists of the root "speech," and the suffixation "less" and "ness."
Physical response	Physically act out a new word to enhance its meaning or the understanding of the word.
Translation	Translate one language to another.
Transfer	Transfer the ideas or rules of known words to those in new words, such as "smooth" can be applied to an object, say, "a smooth table" and such meaning can be transferred to have an abstract meaning like "a smooth day."
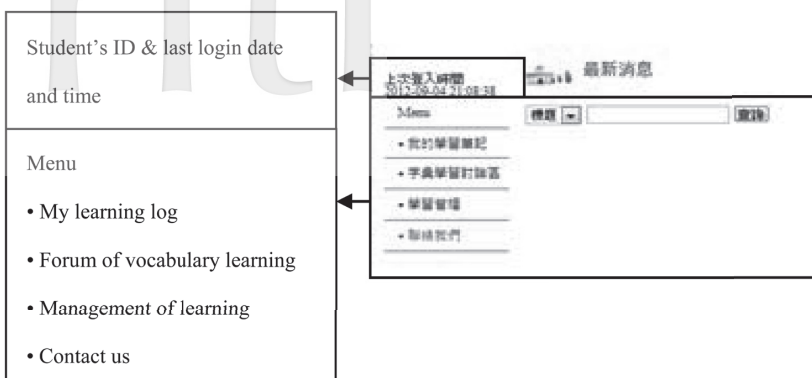
Figure 1
Entry Page of the System
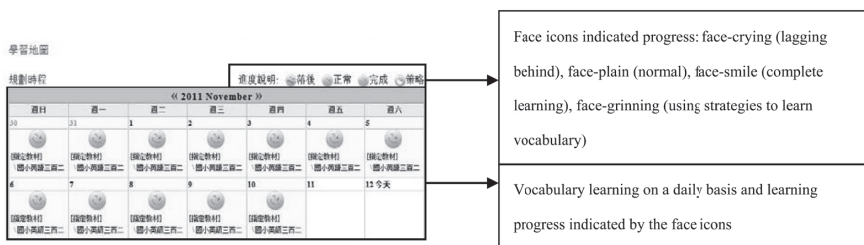
Figure 2
"My Learning Log"—Learning Progress Calendar
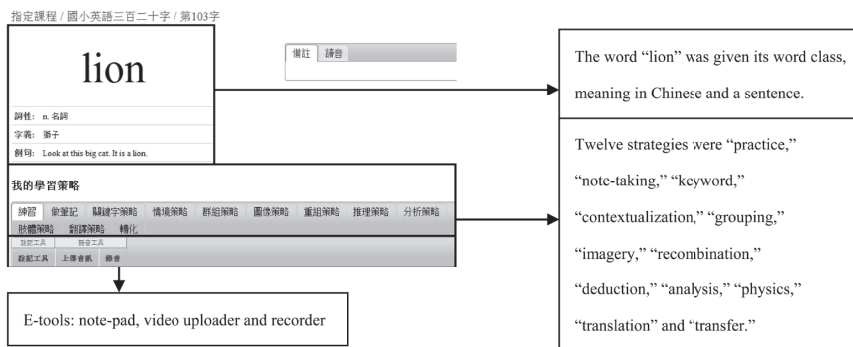
Figure 3
Learner Interface

a mind-map to learn words with relevant concepts, say, "family" with "family members," the learner could use the tool to organize relevant words like "father," "mother," "brother," and "sister" by drawing lines and linking them to the central idea of "family." In this case, learners had complete leeway to select strategies with tools to learn new vocabulary words. Indeed, this system was exclusively designed to promote students' self-regulated learning.

As for the teacher interface (Figure 4) it was similar to the student one, but its functions allowed teachers to upload vocabulary words as students' learning materials, to create and manage students' profiles (e.g., students' background information), and importantly, to monitor students' strategy use, such as frequencies and percentages of each strategy use.

METHOD

Participants

Two classes of 47 sixth grade students were randomly assigned to the experimental (N = 24) and the control (N = 23) groups. All students spoke Mandarin Chinese or Taiwanese as an L1 and none had ever lived in an English-speaking country. The students were recruited from an elementary school in Taipei City, Taiwan. The homogenous group of 12-year-olds had been studying English as a core subject for approximately six years and were considered as having a similar proficiency level in English according to English grades from the previous academic term, with the majority of the students having a grade point average (GPA) above 80%.
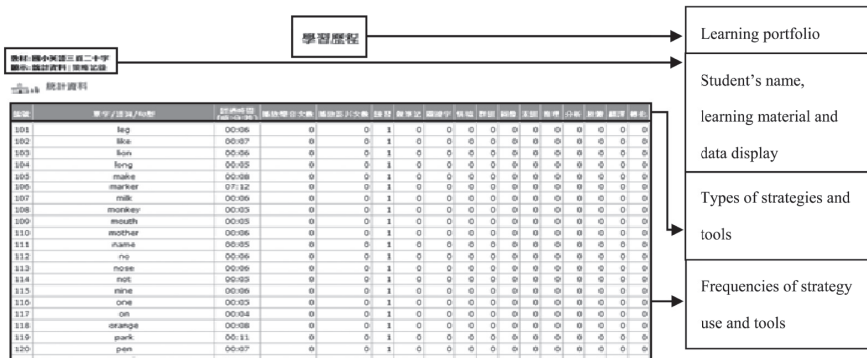

Figure 4
Teacher Interface

Materials and Instruments

Learning materials. A list of words was uploaded into the TESU system as a self-regulated learning material that would enable the participants to learn the vocabulary during this experiment. Both the experimental and control groups used the same learning material, but the former learned the words in the system while the latter learned the words from paper-based notebooks. The 320 must-learn vocabulary list was derived from the Ministry of Education in Taiwan which indicated that a certain range of vocabulary, such as "elephant," "monkey" and "green," must be acquired by the sixth graders.

Online vocabulary recognition tests. The online pre- and post-tests were administered in order to measure the participants' English vocabulary abilities in the initial stage and to calculate their vocabulary gains in the latter stage. Such a view of vocabulary abilities often refers to the notion of knowing a word as a learner is able to correctly recognize it in order to activate understanding of lexical knowledge in relation to reading and listening, rather than the productive knowledge for speaking and writing skills (Laufer & Goldstein, 2004; Pignot-Shahov, 2012). In this study, the participants were tested with the receptive knowledge of the target vocabulary. Both the vocabulary pre-test and post-test contained identical test items consisting of two sections: (1) multiple choice questions for English vocabulary words, e.g., "My _____ was an English teacher" with three distractors: "grandpa," "house," "school," and "classroom;" and (2) multiple choice questions for Chinese meaning, e.g., the English word "bathroom" with three other distractors: "臥室 (bedroom)," "廚房 (kitchen)," "浴室 (bathroom)," and "儲藏室 (storage)." Examples of these questions for each section are given in Appendix. Each section contained 100 test items; one item was worth one point. There were 200 points in total for two sections.

The online pre-/post-test system was separate from the TESU, and this required each student to log in with a given username and a password. The questions on the online test were randomly drawn from the test items in the system. Throughout the test, each multiple-choice question appeared at a time on the computer screen, where the elapsed time was shown in the top right corner of the screen.

Vocabulary written recall. The participants' vocabulary knowledge was further tested by using an immediate vocabulary written recall instrument that assessed productive word knowledge in order to provide a complementary measure to the receptive word knowledge as discussed in the preceding sub-section. Unlike the recognition test,

the production test was a more difficult test assessing word knowledge. However, the production test was not necessarily superior to the recognition test. The former test simply provided complementary evidence to the latter result, though the triangulated data was not the primary focus of the current study.

The words for the recall test were selected and suggested by two experts in SLA. There were two lists each containing 15 words rather than one list of 30 words. Fifteen words in one list for a learner's cognitive load were deemed more appropriate than 30 words for a learner's cognitive load. Also, in each list, five words were more challenging because the words were not from the 320 must-learn words in an attempt to have the participants employ learned strategies. The use of more difficult vocabulary was to avoid a potential situation for some students where the 320 must-learn words might have been too easy to engage the participants in strategic processing. If knowledge becomes automatic, the participants are no longer using any strategies to retrieve the knowledge according to Cohen, Weaver, and Li (1995).

In each list, 15 English words with meanings in Chinese were given to the two groups of participants for the recall test. The first list of words included "marker," "university," "blog," "pants," "lorry," "pepper," "victory," "pillow," "hungry," "logo," "ice cream," "goal," "restaurant," "dance," and "pull." The second list of words contained "weird," "ladybird," "letter," "cello," "flower," "lyrics," "vain," "tag," "jump," "rain," "cloudy," "socks," "Mandarin," "windy," and "supermarket." One word written correctly scored one point, and there were a total of 30 points. The words recalled from the experimental and the control groups were counted by the researchers. Unrecognizable words written by the participants were excluded.
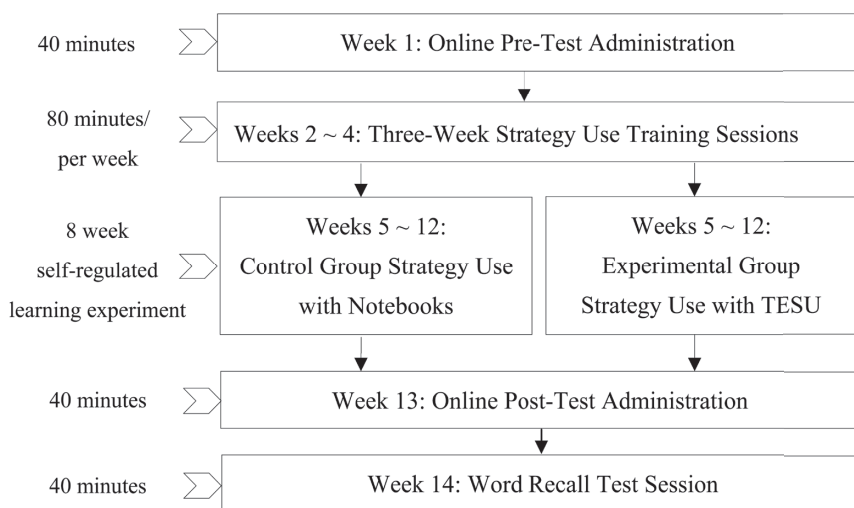
Procedures of Data Collection

The researchers first contacted the principal of the elementary school and discussed the research agenda, and then sent the written consent form to the students' parents to briefly describe the research plan. After obtaining parental permission, the researchers went to the two classes to meet the students and to inform the students of the project and when the project would commence. Afterwards, the researchers conducted a pilot test in order to assess the designed materials and measure the time spent on the word recall test: with 15 sixth-grade students from the chosen school, who were not participants in the study.

The 40-minute online vocabulary pre-test session was organized in the first week, as shown in Figure 5. Three-week training sessions

were then conducted, each lasting 80 minutes per week, 240 minutes in total. The purpose of the training sessions was to help the participants to become familiar with the twelve types of strategies, such as keyword and contextualization. For the experimental group, each training session was divided into three phases; strategies were first modelled by one of the researchers, followed by some examples, as suggested by Atay and Ozbulgan (2007), and the participants then worked individually via the system. The above procedures were performed in the control group except for using the TESU system. The control group used A4 size notebooks provided for the group to record strategy use. Note that the twelve types of strategies in a paper-printed version in Chinese were displayed in the notebook which allowed the participants to consult the strategies at any time.

The eight-week experiment commenced in Week 5, all the participants were encouraged to use the taught strategies to learn the 320 vocabulary words. The students in the experimental group accessed the system from home or at the school and indoor or outdoor settings, whereas the students in the control group carried notebooks to write down the strategies they used when learning the list of words. It is worth mentioning that in the first three weeks of the experiment one of the researchers entered both classes to help the participants to remember the strategies and each visit lasted approximately 20 minutes. All vocabulary words to be used as examples in the entire experiment were not those in the 320 must-learn vocabulary list.

Figure 5
Procedures of Data Collection

The online post-test approximately 40 minutes in duration was administered following the experiment. In Week 14, a recall session was held; each group spent approximately 40 minutes to recall two lists of 30 English words. The participants were sub-divided into small groups, four groups in total, and each group consisted of five or six students. All participants were each given A4 size papers. The first list of 15 words were presented on a poster, 31 inches wide × 43 inches long, which was put on the blackboard. The participants were allowed five minutes to memorize the given words. Interestingly, most of the participants spent less than five minutes and asked whether they could start writing down the words because they said they might forget the words. Second, they were allowed 5 ~ 10 minutes to work on writing down the words in English. After 5 minutes, the second list of vocabulary words was administered in the same manner as the first one. The recall task was completed in the presence of one researcher and two research assistants; all the students were told that they were not allowed to see each other's answers and to change their answers. When the participants looked at their words/notes in hand, the participants were able to focus on how they remembered the recalled words during the group discussions. The purpose of doing this was to gather some informal but useful information concerning vocabulary strategy use. At the end of the session, the researcher and the research assistants collected all the notes of the individuals in order to process numerically.

RESULTS

The aim of this study was to investigate the effects of the prototype TESU system on EFL students' vocabulary acquisition. In Table 2, the sample consisted of two intact classes of 47 sixth grade students which were randomly assigned to an experimental group and a control group. There were 13 boys and 11 girls in the experimental group and 12 boys and 11 girls in the control group. The results in terms of vocabulary gain and strategy use will be presented quantitatively in the following analysis of the data.

Table 2
Background Information of the Participants

	N	Age	Gender
Group 1 (Experimental Group)	24	12	M = 13, F = 11
Group 2 (Control Group)	23	12	M = 12, F = 11

Differences in the Online Vocabulary Pre- and Post-Test Between the Groups

The Independent-samples t-test was first calculated to determine whether the vocabulary knowledge of the two groups differed significantly prior to the experiment. The results show that there was no significant difference between Group 1 (pre-test, N = 24, M = 99.6, SD = 53.5, $SE\ Mean$ = 10.9) and Group 2 (pre-test, N = 23, M = 108.6, SD = 51.3, $SE\ Mean$ = 10.7), as the p value was .56 at 95% CI for mean difference (-39.8, 21.8) (t = -0.59, df = 45, p > .05). The mean difference between the scores of Groups 1 and 2 accounted for -9.0. As can be seen, Group 2 performed on the pre-test slightly better than did Group 1, in which the mean scores of the groups, 99.6 and 108.7, did not reach a level of significance.

The Independent-Samples t-test was calculated again to measure the scores of the post-test. Table 3 shows a significant difference between Group 1 (N = 24, M = 153.4, SD = 56.2, $SE\ Mean$ = 11.5) and Group 2 (N = 23, M = 113.2, SD = 52.0, $SE\ Mean$ = 10.9, p < .014) at 95% CI for mean difference (8.4, 72.0) (t = 2.55, df = 45, p < .05). This result indicates that Group 1 outperformed Group 2 in vocabulary gain, with a mean difference between Groups 1 and 2 of 40.2. From the above statistical results, the researchers assumed that the previous vocabulary knowledge of the two groups was similar, but the results of the students' post-test showed a significant difference in the vocabulary gain between the groups as the magnitude of the differences in the means was a medium effect (Field, 2009). The effect size (Eta squared = .35) suggests that the experimental group demonstrate better vocabulary knowledge than the control group during the experiment.

Types of Vocabulary Strategy Use by the Experimental Group

Types of strategies were identified and recorded in the TESU system. Table 4 shows the 4,366 attempts of the total for strategy use by

Table 3
Results of Independent-Samples *T*-Test for Students' Post-Test

	N	*Mean*	*SD*	*SE Mean*	*t*	Eta squared
Group 1 (Experimental group)	24	153.4	56.2	11.5	2.55	.35
Group 2 (Control group)	23	113.2	52.0	10.9		

the experimental group. Of these, the strategy "practice" outnumbered other strategies, such as "note-taking," which accounted for 77.92%. This was followed by the translation strategy at 6.09%. Such statistics suggest that the participants in the experiment were much more likely to use the "practice" strategy rather than to use other strategies, an indication of using a rote memorization method to remember vocabulary words. Moreover, the strategies of contextualization and note-taking which resulted in 5.74% and 5.26% respectively were less likely to be employed by the participants.

To further exemplify how the participants actually employed the strategies through the use of the TESU system, four examples of strategy use by four participants are presented. Figure 6(a) shows a practice strategy related to learning the word "boy." The participant recorded his pronunciation when practicing this word in both Chinese and English. In the second example, the strategy "translation" was employed by using a note-pad tool to learn the word "pig." In Figure 6(c), an imagery strategy was used to create a visual image of the word "cow," where the participant used a drawing tool to make the picture of a cow. In Figure 6(d), the participant creatively employed a keyword method in using a note-pad tool to write the Chinese character " 靠 " since it is pronounced as "kào" similar to the "cow" in English.

The above statistical results suggest that the participants in the experiment preferred using the "practice" strategy, even though they were given a number of other options. This indicates that the participants employed a rote memorization method by writing or saying a word in repetition to retain vocabulary words.

Differences in Vocabulary Written Recall Between the Groups

The words from the learning material of 320 must-learn vocabulary list were successfully recalled by the two groups of students, e.g.,

Table 4
**Frequencies of Vocabulary Strategy Use by the Experimental Group**

	PR	NO	KE	CO	GR	IM	RE	DE	AN	PH	TR	TF	Total
Total	3,402	230	93	251	16	38	16	12	4	10	266	28	4,366
%	77.92	5.26	2.13	5.74	0.00	0.00	0.00	0.00	0.00	0.00	6.09	0.00	100

Note. Types of strategies: PR = practice, NO = note-taking, KE = keyword, CO = contextualisation, GR = grouping, IM = imagery, RE = recombination, DE = deduction, AN = analysis, PH = physical response, TR = translation, TF = transfer.

"pants," "hungry," "ice cream," and "restaurant" in the first list and "jump," "letter," "rain," and "flower" in the second list. Among the words which were not from the learning material, such as "Mandarin," "weird," and "lyrics," they were unlikely to be recalled by the two groups of participants, but the compound word like "ladybird" was remembered by most of the participants. Furthermore, when asked how they remembered words such as "logo" and "rain," several participants in both the experimental and control groups reported using a keyword method for "logo" as it sounded as "hot dog" (熱狗) in Chinese. They also employed a transfer strategy for "rain," that happened to be a well-known Korean pop signer's stage name.

The total number of words recalled by the experimental and the control groups were calculated by using the Independent-samples t-tests to compare the mean scores of the groups (Pallant, 2005). The results, presented in Table 5, demonstrate that the experimental group outperformed the control group, and the mean scores of both groups differed significantly. According to this, the average score for the words recalled by the sub-group participants in the experimental group was 16.63 (N = 24, SD = 6.05, $SE\ Mean$ = 1.24), meaning that most participants were able to remember more than half of the words in the word recall
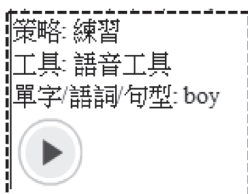
(a) A Practice Strategy Employed by Using a Recorder
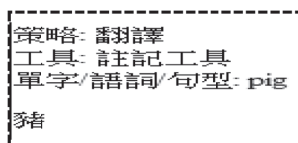
(b) A Translation Strategy Use by a Note-Pad Tool

(c) An Imagery Strategy Employed by Using a Drawing Tool

(d) A Keyword Method Employed by Using a Note-Pad Tool

Figure 6
Examples of Strategy Use Taken From the TESU System

test. In contrast, the mean score for the control group was 12.87 (*N* = 23, *SD* = 4.34; *SE Mean* = 0.91), meaning the students recalled approximately 13 words. The mean difference between the groups was 3.76 at 95% CI for mean difference (0.6, 6.9) (*t* = 2.43, *df* = 45). The magnitude of the difference in the means was between a moderate and a medium effect size (eta squared = .34), according to the guidelines which are provided by Field (2009). The above results concerning the effect size indicate a noticeable difference in the recall test scores between the groups suggesting that the experimental group perform better than the control group in the vocabulary recall.

DISCUSSION

Several findings emerged from this investigation. First of all, the statistical test results indicate that the experimental group gained more vocabulary words than did the control group during the experiment as the scores of the post-test differed significantly between the two groups. This difference could be explained to some extent because the participants were motivated to learn vocabulary words via the TESU system. The tools such as YouTube and recorder provided in the system increased learning interest and extended the learning time spent using the TESU system. Zhao and Lai (2008) state that technology enhances language input, improves learning and sustains learners' motivation. Also, a number of CALL-based studies have reported that uses of multimedia annotation can indeed foster learners' motivation and interest in learning L2 vocabulary, such as Al-Seghayer (2001).

Secondly, strategy use seems to have been influenced by how strategies are taught in the classroom. As revealed by the participants' English teacher, students practiced English vocabulary in a traditional way, translating from Chinese to English or vice versa in writing or verbally during English classes. Such rote memorization or other forms

Table 5
Results of Independent-Samples *T*-Test for Word Recall
(30 Words in Total)

	N	*Mean*	*SD*	*SE Mean*	*t*	Eta squared
Group 1 (Experimental group)	24	16.63	6.05	1.24	2.43	.34
Group 2 (Control group)	23	12.87	4.34	0.91		

of memorization, is generally preferred among Asian students more than among any other culture of students (Gu, 1994, 2005; Oxford, 1996), which requires less effort and time from the learners. This can be equally explained by the employment of vocabulary or language learning strategies being greatly affected by the learners' age; young children tend not to use new learning tactics in comparison with adult learners, who may have higher levels of self-directed learning and motivation because of extrinsic reasons, e.g., the ability to master English is part of a job requirement.

Thirdly, the word recall test indicates that the experimental group performed better than the control group. Although in the word recall test the mean score of the experimental group was approximately 16 words (30 words in total), whereas the mean score of the control group was 12 words, the difference between the groups was significant. The result can be explained to some extent by the impact of the TESU system on the word recall as it enabled the experimental group learners more aware of strategy use than the control group learners who did not use the system.

Fourth, as found in the strategy use data collected in the TESU system, the majority of the participants in the experimental group tended to employ rote repetition strategies. The finding of this study suggests that strategy use needs to be taught explicitly within the classroom as recommended by some intervention studies like Atay and Ozbulgan (2007) and Mizumoto and Takeuchi (2009). It is beneficial to teach students within the classroom: not only will strategy instruction motivate students to learn the target language, but will also help students to learn to transfer the strategies to various situations outside the classroom.

Fifth, this study has shed some light on the understanding of whether vocabulary strategy use was associated with vocabulary gains between participants using the system and participants not using the system. In the latter group, they did not contribute any effort to the vocabulary learning by recording strategies in their notebooks during the eight-week experiment in spite of having been taught the strategies. This may be the reason that young children lack self-regulated learning ability (e.g., to be aware of their own learning processes) not to mention self-directed ability (e.g., to decide what to learn). Indeed, levels of depth in learning are related to the age and experience of an individual, as 11th-graders tend to be better strategy users than 8th-graders (Zimmerman & Martinez-Pons, 1990). Hence, such findings have potential pedagogical implications: teaching learners of L2 or FL strategy use explicitly may benefit self-direct learning (Oxford, 1990); on

the other hand, use of the TESU system may help enhance consciousness of strategy employment.

This study investigated the use of vocabulary learning strategies via the TESU system to collect data related to the vocabulary learning strategies employed by the learners in the experimental group. The system provided quick access to the data kept in this system when students used it. In addition, the TESU allowed the students to access internet resources like "YouTube" and "recorder," which were familiar and might have fostered learning interest. The utilization of CALL to gain an attainment in L2 corroborates the findings of previous investigations, such as Gorjian et al. (2011).

Issues raised in this study will guide the researchers to revise the system for future studies. There is a need for the system to contain a sharing function permitting the students to learn from others, and to assist the students to employ strategies other than the rote repetition strategies. Therefore, to provide peer or teacher feedback on the strategy use in the system will be needed to broaden strategy employment. Furthermore, in comparison with the effects of strategy use on vocabulary gain, this system may have been accessed with mnemonics, like keyword or/and imagery, and with rote repetition, like practice. By doing so, the system will need to make some changes on the learner interface, that will allow certain strategies functional and other strategies that are dysfunctional.

The study in the initial stage has some limitations. The small sample size may prohibit the generalization of the findings. In addition, the system cannot provide feedback on the learners' strategy use. Thus, future research will need to investigate how the modified system helps learners employ and develop vocabulary strategy use, or how students use this system to provide feedback to their peers in the development of strategy employment. Lastly, the vocabulary gains revealing the significant difference between the experimental and the control groups are limited to certain types of lexical knowledge, such as recognition and written recall.

CONCLUSION

This study investigated the effects of the TESU system on vocabulary gains during the experiment as it established its theoretical framework by incorporating language learning strategy use in the realm of L2. The statistical results derived from the data answered the research questions using the effect sizes to determine the differences in the vocabulary post-test and the written word recall test between the

experimental group and the control group. The results indicated that the experimental group outperformed the control group in relation to vocabulary gains during the experiment. Moreover, the experimental group preferred employing the practice strategy (e.g., saying or writing a word repeatedly). The findings of this study also indicated that using the vocabulary learning system was feasible in terms of statistically computing the strategy use.

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APPENDIX

Examples of the Online Vocabulary Recognition Tests

A. 請選擇下列適當的選項，補上句子的底線處，完成正確的句子。
(Please choose an answer for each blank that best fits the meaning of a sentence)
1. My _____ is tired and sleeping in the sofa.
   (1) chair (2) work (3) park (4) mother
2. Did you _____ the picture on the wall?
   (1) see (2) sleep (3) jump (4) sing
3. I _____ a sister and three brothers.
   (1) work (2) have (3) cook (4) think
4. The little girl is _____. She must be hungry.
   (1) crying (2) teaching (3) drinking (4) sleeping
5. What is your _____'s name?
   (1) color (2) book (3) pen (4) dog
6. You are sick. You must see a _____.
   (1) doctor (2) hospital (3) store (4) friend
7. There are many _____ working at this hospital.
   (1) schools (2) nurses (3) students (4) bees
8. He is _____ little brother.
   (1) he (2) I (3) Her (4) my
9. I have a ____, three pencils and two pens in my pencil case.
   (1) ruler (2) park (3) moon (4) cake
10. I'll buy some _____s for my girlfriend.
   (1) sing (2) flower (3) yellow (4) cloudy

B. 請選擇符合題目意義的選項。
   (Please choose an answer for each question)
1. use
   (1) 研讀 (2) 使用 (3) 唱歌 (4) 喜歡
2. chair
   (1) 椅子 (2) 桌子 (3) 沙發 (4) 電腦
3. have
   (1) 看 (2) 跑 (3) 玩 (4) 吃
4. home
   (1) 學校 (2) 車 (3) 家 (4) 車站
5. jump
   (1) 走 (2) 跳 (3) 想 (4) 笑
6. good
   (1) 壞的 (2) 好的 (3) 甜的 (4) 酸的

7. windy
   (1) 多風的 (2) 下雨天 (3) 多雲的 (4) 冷的
8. help
   (1) 洗衣 (2) 掃地 (3) 煮飯 (4) 幫助
9. open
   (1) 煮飯 (2) 吃 (3) 打開 (4) 拉
10. cry
   (1) 哭 (2) 笑 (3) 生氣 (4) 高興

科技輔助學習策略對二語字彙習得成效之研究

摘 要

過去許多實證研究與相關文獻證實，字彙能力是影響第二語言或外語溝通能力的主要因素之一。近年來，多媒體科技與電腦輔助語言學習觸角已逐漸延伸到第二語言與外語的學習，其主要目的不外乎是想提升外語學習者的學習成效。本研究設計開發一套系統——輔助字彙學習策略平臺 (TESU)，提供多樣化與人性化的字彙學習，包括十二種不同字彙學習策略與五種平臺內的系統學習工具，如「註記」與「心智圖」等，能讓學習者在課餘時間使用該平臺學習英文單字，希望學生使用平臺內的策略與工具，將所學的英文單字作內化深層處理 (deeper processing)，促進自發性的學習，以提升學習者的字彙能力。本研究旨在探討該平臺對國小學童英文單字學習成效之影響，參與者為臺北市某市立國小六年級的學生，共 47 位學生，兩班隨機分派至實驗組與控制組。實驗前，學生接受線上單字前測，測試結果發現兩組學生表現並無顯著差異。實驗後，兩組學生接受線上單字後測與單字書寫回想測試，結果發現實驗組表現優於控制組，獨立樣本 t 考驗數據達到顯著性的差異 ($p < .05$)。除此之外，本研究調查結果證實，使用此科技輔助字彙學習平臺不僅有效幫助學習者習得新的單字，而且可利用該平臺蒐集學習者的字彙策略使用數據。再則，經由本研究證實得知，此科技輔助字彙學習平臺可鼓勵國小學童練習一些顯少使用的字彙學習策略，如「關鍵字」。

關鍵詞：科技輔助字彙學習策略平臺　第二語言或外語　字彙學習
　　　　策略使用