

VOCABULARY LEARNING IN AN AUTOMATED GRADED READING PROGRAM

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Adult L2 learners are often encouraged to acquire new words through reading in order to promote language proficiency. Yet preparing suitable reading texts is often a challenge for teachers because the chosen texts must have a high percentage of words familiar to specific groups of learners in order to allow the inference of word meanings from context. With the help of word lists research and advances in quantitative corpus analyses using word frequency computer programs, this study selected sixteen articles from the computer corpus of a local Chinese-English magazine and used them to construct an online English extensive reading program. A preliminary assessment of the reading program was conducted with 38 college students over twelve weeks based upon vocabulary gains from a pretest to a posttest. The results showed that learners improved their vocabulary scores after using the reading program. The online extensive reading syllabus demonstrated that such a design for a reading program is technically feasible and pedagogically beneficial and provides value in both vocabulary gains and learner satisfaction.

INTRODUCTION

Extensive reading, reading with "large quantities of materials that is within learners' linguistic competence" (Grabe & Stoller, 2002, p. 259), purportedly helps in vocabulary learning by creating opportunities for inferring word meaning in context (see, e.g., Krashen, 2004). However, studies have revealed that extensive reading for second language (L2) vocabulary development may lead to such problems as incorrect inferences, lack of retention, and, ultimately, vocabulary learning that does not allow learners to use words actively and productively (Hulstijn, 1993; Wesche & Paribakht, 2000). The problem of guesses that are incorrect can be ascribed to the fact that unlike native speakers, L2 learners often lack the word knowledge necessary to make accurate inferences of word meanings from context. Correct inferences of word meanings are conditional upon accurate recognition of surrounding words and sensitive use of reading strategies (Huckin & Coady, 1999). Laufer (1989) observed that learners whose vocabulary size enabled them to cover 95% of the words in a text were successful in developing an adequate level of comprehension. However, other studies show that L2 learners commonly lack sufficient word knowledge to support successful guessing and often do not actively use the reading strategies that might aid successful comprehension (Chen, 1998; Grabe & Stoller, 1997). Thus the chances of comprehending unsimplified authentic texts are frustratingly low, with the chances of effective vocabulary acquisition lower still.

In addition to learners' limited language competence, restricted reading opportunities with re-encounters of new words pose yet another stumbling block. Word knowledge is a continuum gradually developed with each encounter of a word in different contexts. Acquiring a word is not simply a process of connecting word form to word meaning, but a complex development involving the learning of grammatical functions such as parts of speech, sociolinguistic factors such as word connotation, and frequency intuitions such as collocation, all over the course of multiple encounters of target words in diverse contexts (Nation, 1990, 2001). However, the frequent and repetitive exposure to target words necessary for the development of word knowledge is often not available in an extensive reading context

because either students have limited time or the reading materials are not appropriate (Paribakht & Wesche, 1997).

The current study reports a research-informed attempt to address the difficulties outlined above by developing an online extensive reading syllabus. The experimental web-based extensive reading environment was designed to facilitate vocabulary learning in two main ways: by providing comprehensible texts sequenced according to word difficulty levels and by ensuring repetition of target words. As in a similar project by Ghadirian (2003), the program sequences reading texts according to the "coverage" offered by lists of high frequency words and offers highlighting of target words, glossing, and online referencing. The program differs from Ghadirian's in that an algorithm for prioritizing texts that offer multiple exposures to target words was devised and built in. To assess the usefulness of our reading program, 38 EFL learners whose mother tongue is Chinese were recruited for participation in the project. We observed the learners' performance on measures of receptive and productive vocabulary knowledge in relation to numbers of encounters with target words in the extensive reading program. Research that explored the effects of three types of computerized assistance-- glosses, sequenced reading, multiple encounters--informed the design of the experimental program and is outlined below.

Computerized Glosses and Vocabulary Learning While Reading

Researchers have maintained that to initiate word acquisition, learners' attention must, at some point, be directed to form-meaning relationships of new, unfamiliar target words to be learned (Ellis, 1995; Schmidt, 2001; VanPatten, Williams, & Rott, 2004; Wong, 2005). Provision of glosses in reading can facilitate vocabulary learning by directing readers' attention toward the meaning of target words when they encounter the word forms, as long as the annotation is not intrusive (Davis, 1989; Hulstijn, Hollander, & Greidanus, 1996; Leefa, 1992; Liou, 2000). Results from empirical studies in learner behavior have pointed to the usefulness of developing simple textual glosses for extensive reading purposes. For instance, a study conducted by Davis and Lyman-Hager (1997) showed that the most frequently consulted annotation type was word translation, which constituted 85% of the information learners had accessed. Likewise, Lomicka (1998) reported students' strong dependence on first language (L1) definitions when word meanings were unknown. Studies of multimedia glosses (Davis & Lyman-Hager, 1997) indicate that even though learners have the options of various annotation types (e.g., pictures, videos, or audio glosses), they nevertheless tend to rely largely on L1 definitions and ignore other options, as their use of glosses is oriented toward the goal of translation and paraphrasing to achieve basic comprehension. Gettys, Imhof, and Kautz (2001) further explained students' behaviors with the concept of human mental capacity. They contended that offering various modes of information might overrun the real needs of readers and thus cause cognitive overload in the process of reading. Similarly, Hegelheimer & Tower (2004) pointed out that, because of the limited capacity of learners' working memory and attention, providing readers with rich kinds of information will likely create unnecessary distraction and disruption. Given technical difficulties and learners' limited cognitive capacity, we reasoned that L1 textual glosses are both feasible and effective for use in computerized extensive reading environments.

Vocabulary Learning Through Sequencing of Reading Texts

Laufer (1989) and Nation (2001) observed that learners whose vocabulary size enabled them to understand the meanings of 95% of the words in a text were successful in developing an adequate level of comprehension. Assuming that learners are able to use contextual inference strategies for vocabulary acquisition, Laufer (1997) and Nation (1993) suggested that a 5,000 word lexicon of general English vocabulary is sufficient for reaching this 95% criterion in non-specialized texts. However, most high school graduates in EFL countries have a far smaller vocabulary than this (Chen, 1998). Thus, many English teachers turn to abridged or simplified texts that can scaffold learners along the process of learning words while reading. Though some researchers have argued against the use of simplified texts

(e.g. Bernhardt, 1984), their role in promoting the acquisition of vocabulary and other aspects of language is widely acknowledged (see Day & Bamford, 1998, for an overview).

However, the sequencing of such graded materials is often based on textbook editors' subjective judgments and instructors' teaching experiences, and can be a very labor-intensive process. Fortunately, recent advances in quantitative corpus analyses and the availability of new frequency-based word lists offer promising solutions to these problems. For instance, Ghadirian (2003) used word frequency analyses as a basis for sequencing a large number of English texts for L2 learners in his experimental *TextLadder* program. The assumption was that the learning burden could be kept to a minimum and the online vocabulary learning environment enhanced by ordering texts so that those containing the most frequently recurring words were presented first. This is based on the principle that words encountered often are likely to be learned before low frequency ones (Cobb & Horst, 2001; Kyongho & Nation, 1989; Nation, 2001). Ghadirian's procedures created an order for arranging reading texts that facilitated incremental vocabulary acquisition.

Close scrutiny of Ghadirian's reading resource suggests room for improvement. First, the quantitative results of Ghadirian's (2003) study show that the percentage of words likely to be unfamiliar was particularly high in the first 10 to 20 texts, ranging from 8% to 16% and about 15 to 40 new words within a 300-word text. This is well above the known-word level recommended by Nation (2001); he has pointed out that "extensive reading should contain no more than 5% unknown tokens and no less than 1-2% to ensure that there is new vocabulary to learn" (p. 150). Second, *TextLadder* was not able to control when or how often learners encountered target words again during the process of extensive reading, and low levels of the reappearance of target words would likely limit incidental vocabulary learning. Only in the tenth or twentieth text could learners re-encounter some of the target words they read in the first text. By this time, these words were already considered as familiar words by the program, yet whether learners had actually acquired them after merely one exposure is questionable. Lastly, Ghadirian (2003) discussed the sequencing and design of *TextLadder* but did not report the effects of using it with actual language learners. The research reported here is based on *Textgrader*, a computerized text sequencing program that draws on Ghadirian's ideas for creating supportive conditions for vocabulary acquisition but includes improvements such as a further reduction of vocabulary load and more frequent exposures to target words. In addition, an investigation of the effects of using *Textgrader* with EFL learner-readers is reported below.

Amount of Word Exposure Needed for Successful Vocabulary Acquisition

Although it has been consistently emphasized that repeated exposure to a word is needed for an incremental learning process, previous studies in both L1 and L2 research have not shown agreement concerning how much exposure is necessary for successful vocabulary acquisition (Horst, Cobb, & Meara, 1998; Nagy, Herman, & Anderson, 1985, 1987; Nation, 1990; Rott, 1999; Saragi, Nation, & Meister, 1978). The likely explanation for these disparate results is the incremental nature of the word learning process. A single encounter with a word in context could already result in some amount of ability to recognize its meaning, while 50 exposures might still not enable learners to build the complete and complex word knowledge needed for productive use. Receptive and productive types of knowledge of a word have commonly been used to describe the degree of learners' word knowledge (Nation, 2001; Read, 2000), and it is generally agreed that learners' vocabulary knowledge can be located on a receptive to productive continuum (Nation, 2001). Learners are likely to first recognize a word's form, pronunciation, and basic meanings; then with further experiences or practice, their word knowledge will move along the continuum and finally reach the point of being able to use these words freely in productive mode. Due to its currency among the measures devised to assess the incremental development of vocabulary learning, Paribakht and Wesche's (1993) Vocabulary Knowledge Scale (VKS) was adopted in the present study. The measure is described in detail in a later section.

THE PRESENT STUDY

The review of selected literature suggests that material developers interested in using technology to construct an environment that facilitates vocabulary learning during reading would do well to build in access to L1 textual glosses, and to draw on the computer's capacity to identify and sequence texts so that learners read those with high levels of known words first and encounter unknown words frequently as they move through the reading materials.

In this study, an online extensive reading syllabus called *Textgrader* was developed following these principles and tested with learners of English. As discussed, the program aims to address the two major difficulties commonly encountered by second language learners in processing unsimplified texts: limited word knowledge and insufficient exposure to target words. The research had two main goals: to evaluate the participants' vocabulary learning outcomes and to determine how much exposure to target words was needed for the development of receptive and productive word knowledge. A set of research questions guides the current study.

- 1) If the online extensive reading program can lead to vocabulary gains on the target learners, what is the relation between amount of word exposure and successful receptive and productive word acquisition?
- 2) What feedback will the learners offer in response to the use of the online extensive reading program?

METHOD

Participants

The participants were 38 Chinese-speaking EFL college freshmen in a public university in Taiwan. These students were from two intact sections of a required Freshman English course. All 38 participants had at least six years of formal instruction from junior to senior high schools and were estimated to be at the intermediate level regarding their overall English competence. Their previous learning experience in schools centered on intensive reading of English texts for grammar instruction with rare extensive reading opportunities.

Designing An Online Extensive Reading Syllabus

Reading texts and four word lists.

The first step in constructing the online syllabus that would provide comprehensible input and offer learners repeated contacts with target words was to find suitable reading texts for Taiwanese college learners. Our goal was to identify texts that provided good opportunities to learn from authentic materials related to home culture. In our view, imported reading materials are too often focused on introducing the culture of English-speaking countries. We sought texts that would minimize any reading difficulties associated with lack of background knowledge. With this goal in mind, we selected texts from issues of the *Sinorama* magazine (recently renamed as *Taiwan Panorama*, <http://www.taiwan-panorama.com/en/index.php>). The *Sinorama* articles are mainly about issues in Taiwan in such areas as politics, economics, arts, society, culture, and ecology. An electronic corpus consisting of 5008 texts dating from 1999 to 2001 was selected for possible use in the project. Next, to ensure that target words appear frequently in the texts so that learners could repetitively encounter them while reading, the procedures implemented in Ghadirian (2003) were followed, using word lists as criteria for screening appropriate texts. A new method of ensuring repeated encounters with new words was devised specifically in our study.

In order to identify texts in the *Sinorama* corpus that offered the 95% known word coverage needed for successful inferring of the targeted unknown words and to sequence them according to percentages of target words in the texts, we drew on lists of high-frequency English words. Based on our knowledge of

the previous English learning experiences of our learners, we felt it was reasonable to assume that the participants would already know items on West's (1953) General Service List (GSL), a list of the 2000 most basic English word families, and the High School Frequent Word List (HSF, Cheng, 2002). The HSF was used as a guideline for writing high school English textbooks in Taiwan.¹

In addition to the two 'familiar' word lists, we also created two lists of target words. Considering our college learners' need to read English academic texts, the University Word List (UWL, Xue & Nation, 1984) was chosen as the first target word list. It consists of 800 word families not included in the GSL or the HSF, but frequently found in academic texts (Nation & Kyongho, 1995). The *Sinorama* High-Frequency Word list (SHF) was selected as the second target word list. It contains 781 word families not in GSL, HSF, or UWL, but frequently used in the 5008 *Sinorama* texts. In sum, words contained in the GSL and HSF were treated as familiar words already acquired by learners, and those in the UWL and SHF were target words that learners were expected to acquire while reading in the syllabus. These four lists together were able to meet the 95% coverage within the *Sinorama* texts. Table 1 contains summarized data relating to the four word lists.

Table 1. Number of Cumulated Words from Four Word Lists and Text Coverage

Word list	Number of cumulated words	Cumulated percentage coverage
Familiar word list		
GSL	7,827	84.70%
HSF	9,712	92.01%
Target word list		
UWL	12,833	93.48%
SHF	13,614	96.61%
Total	13,614	96.61%

Sequencing of reading texts.

After determining suitable reading texts and word lists, we began to sequence reading texts in an order that could provide learners with comprehensible input and increase their exposure to target words with the aid of a computer database program. First, from the 5008 texts in *Sinorama*, we selected only those with a length of 1500 to 3000 words. Second, we examined the remaining texts by comparing them to the four word lists; texts not reaching 95% coverage of words in the four lists were excluded. These processes left us with 124 reading texts out of the 5008 in the *Sinorama* corpus. Third, running words in these 124 texts were compared with those in the familiar word lists, GSL and HSF, and target word lists, UWL and SHF. Our computer program sifted through the texts and sequenced them according to vocabulary difficulty. The text that contained the smallest number of target words and highest number of familiar words occurred first in the sequence as the easiest. Up to this point, the ordering procedures replicated those in Ghadirian's (2003) except for the use of HSF and SHF word lists. However, we took several additional steps to increase encounters with target words to ease the learning.

In order to create more favorable vocabulary learning conditions in our reading program, we highlighted all target words in the reading texts in red on the screen and glossed them with Chinese translations to raise readers' awareness and attention. After the target words appeared for the first time in red, they were highlighted in green and also glossed with translations in later readings. Such highlighting is in line with the studies on textual enhancement which found typographical enhancements effectively draw learners' attention to target forms (Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995; Shook, 1994; Wong, 2003, 2005).

After the learners read the first text in the sequence, the program did not immediately add the target words in the first text to the familiar word lists as was done in Ghadirian's *TextLadder*. Instead, to ensure

repetition, our program put exposed target words in another newly created word list, the Exposed Word List, for target words that had appeared once. With this new list, our program sifted through texts again looking for the one that contained the smallest number of target words and the highest number of familiar words; however, this time a new screening criterion was added by using the Exposed Word List. In order to ensure repetitive exposure of target words, the program searched for a text that not only contained the highest number of familiar words and the smallest number of target words; but one that also contained the highest number of words in the Exposed Word list (target words from previous texts in the sequence).

Table 2. Procedures in Sequencing Reading Texts

Sequence of procedures	Purpose	Program Action	Outcome
Step 1	For appropriate length of reading texts	Select texts with 1500 to 3000 words	959 texts met the qualification
Step 2	For trimming off the texts that do not meet 95% coverage from the four word lists	Compare the running words in every text to the four word lists (GSL, HSF, UWL, and SHF)	
Step 3	To select the easiest text (the first reading text on the sequence) for learners	Compare words in every text with the familiar word lists (GSL and HSF) and target word lists (UWL and SHF)	
Step 4	Same as Step 3	Select the easiest text that has the highest number of familiar words and least number of target words	Text #1 (the easiest text or the first text on the reading sequence) is selected
Step 5	To select the second text on the sequence	Target words in Text #1 are added into the Exposed Word List	The Exposed Word List has target words from Text #1
Step 6	Same as Step 5	Select the one text that meets the following three criteria: a. The highest number of familiar words. b. The least number of target words. c. The highest number of words in the Exposed Word List.	Text #2 (the second easiest text or the second text on the sequence) is selected Text #2 is not only the second easiest text but also contains the most target words from Text #1

For example, if the first text in the sequence order had four target words, e.g., *administrative*, *hypnosis*, *entrepreneur*, and *faculty*, after learners read the text, the four words would be removed from the target word list and included in the Exposed Word List. After the first text in the sequence was selected, the program then went through the remaining texts looking for the next easiest by comparing familiar words and target words to texts, and also with one more searching guideline, identifying the particular text that

contained the highest number of words from the Exposed Word List. The second text selected then might have a new set of target words, for example, *epidemic*, *calligraphy*, and *deputy* (highlighted in red), but also include target words from the first text, *administrative*, *hypnosis*, *entrepreneur*, or *faculty* (highlighted in green). The second text was the second easiest, and the text that had the greatest number of target words from the first text. After the second reading, the program automatically added the target words in the second text to the Exposed Word List (which would now contain target words from the first *two* texts) and again went through the same sifting process for the next text. In other words, the Exposed Word List ensured that the target words appearing in the previous texts would reappear in the following texts. The above procedures are presented in Table 2.

For the purpose of a preliminary assessment on learners' vocabulary acquisition within a manageable instructional period of twelve weeks, we used only the first sixteen texts in the sequence of all chosen texts for extensive reading practice. These sixteen texts contained a total of 223 target words that varied in numbers of occurrences. Three comprehension questions focusing on the content of the text rather than the target words were devised and presented at the end of every text. Learners were able to respond to these questions online and received immediate feedback concerning the correctness of their answers. Figure 1 illustrates the first reading text from the syllabus (The page can be accessed by going to <http://candle.cs.nthu.edu.tw>. Use candle/candle to login, choose *Textgrader* under the Reading component, and click on the first article to start).

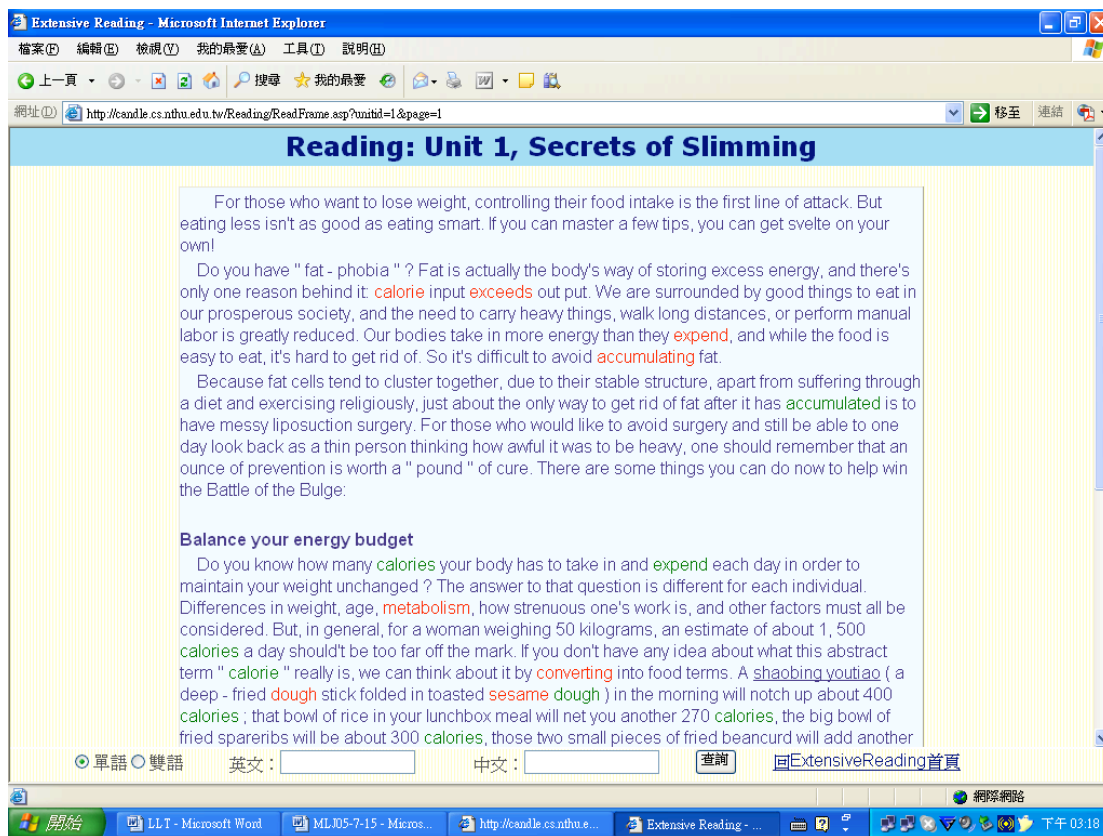


Figure 1. A reading text from the online extensive reading syllabus

After the sequencing procedures and web programming, the sixteen texts in the syllabus demonstrated a satisfactory average target word rate (the proportion of target words per words of running text) of 1.9%. For example, the first two reading texts placed on the syllabus demonstrated target word coverage rates of 2.4% and 3.4% respectively. That is, the first two texts contain 97.6% and 96.6% of 'familiar' words. Of the 223 target words in the sixteen texts, 151 appeared one to two times, and 72 appeared three times or

more. The distribution of the amount of word exposure in the sixteen reading texts is shown in Table 3. This distribution differed considerably from Ghadirian's *TextLadder* (2003), in which five exposures of target words were dispersed over 300 texts with no control on the interval of exposure. As is shown in the statistical results, our goals of controlling new word rate and ensuring repetitive target word exposure were thus achieved.

Table 3. Distribution of Target Words in the Sixteen Reading Texts

Group Number	Number of target word exposures	Number of target words
Group 1	Words appearing 1-2 times	151
Group 2	Words appearing 3-4 times	43
Group 3	Words appearing 5-6 times	13
Group 4	Words appearing 7-8 times	4
Group 5	Words appearing more than 9 times	12

Research Instruments

Pretest

For the purpose of exploring the amount of exposure needed for successful vocabulary acquisition, the pretest aimed to identify target words that were totally unfamiliar to all 38 learners and to assess learners' entry vocabulary level before the extensive reading activity. The pretest consisted of a total of 60 items, including 50 target words (see Appendix) randomly chosen from the 223 in the target word pool and 10 familiar words from the familiar word lists. Participants reported their knowledge of these words by marking a check by the words they had seen before and tried to provide an English definition or Chinese translation beside these words. The 50 target words and 10 familiar words in the pretest items were marked separately, with each correct familiar word receiving 10 points and each correct target word 2 points, for a maximum of 100 points in each case (50x2, 10x10). Words with correct answers from any of the learners were considered 'known' words and excluded from the list of targets.

Posttest

To measure vocabulary gains after the online extensive reading activity, we selected the Vocabulary Knowledge Scale (Paribakht & Wesche, 1997; Wesche & Paribakht, 1996). According to its creators, the VKS aims "to capture initial stages or levels in word learning that are subject to accurate self-report or efficient demonstration, and that are precise enough to reflect gains during a relatively brief instructional period" (Wesche & Paribakht, 1996, p. 33). An example of the scale with the self-report categories for an example word *institute* appears in Table 4.

Table 4. Examples of Self-Report Categories in the VKS Elicitation Scale

Word: Institute	Self-Report Category
I.	I don't remember having seen this word before.
II.	I have seen this word before, but I don't know what it means.
III.	I have seen this word before, and I think it means _____. (synonym or translation)
IV.	I know this word. It means _____. (synonym or translation)
V.	I can use this word in a sentence: _____. (If you do this section, please also do section IV).

The self-report categories were translated into the learners' native language, Chinese, so that learners could fully understand how to do this test. The VKS posttest consisted of the same 50 target words used

in the pretest. The scoring followed procedures outlined by Wesche and Paribakht (1996). For each target word it yielded a score from 1 to 5, from "never having seen the word before" to "being able to make a correct sentence with it". For sentence scoring, two English teachers were involved and their scores were averaged to obtain the final score. When there were discrepancies, they met to discuss in order to achieve a consensus.

Questionnaires

Questionnaires of two kinds were designed to examine the participants' background and their attitudes toward extensive reading. The questionnaires were in Chinese to limit the possibility of misunderstanding due to their limited English ability. The first questionnaire, the Background Questionnaire, enabled us to obtain information on learners' computer use and Internet access at home, their perspectives on English learning, and their experiences with extensive reading. This 17-item questionnaire was designed on a 5-point scale in the Likert format. Similar in format, the Evaluation Questionnaire had 20 items relating to the participants' perceptions of the effectiveness of the online extensive reading syllabus concerning four aspects: system interface design, features fostering vocabulary learning, features of reading texts, and motivation for future use.

Procedures

The design and implementation of the online extensive reading syllabus was constructed on a web platform first. Then, the participants completed the Background Questionnaire and pretest. They subsequently completed 16 reading texts online at home in a period of 12 weeks, which included both their winter break, when there was no formal English instruction and only a limited amount of English exposure was available, and the first month of a new semester. We monitored the learning process from the records of an online tracker program and offered help via email when necessary. Finally, participants completed the posttest and the Evaluation Questionnaire.

RESULTS

From learners' responses to items in the Background Questionnaire, we discovered that a very high percentage of the learners (94.7%) used computers frequently; however, only 7.9% of them used Internet resources to learn English on a regular basis, and only 26.3% had past experience in using computers to assist language learning in English classes. For questions on learners' past extensive reading experiences, up to 78.9% had been encouraged to form the habit of reading regularly by their English teachers before, yet only 13.2% of them had extensive reading habits. The main reasons for not having extensive reading habits were that they did not have time for reading or they could not locate suitable materials.

Comparison of Scores in the Pretest and Posttest

In order to address the first research question, several statistical analyses were conducted. First, the independent t-test was used to examine whether learners' performances for familiar and unfamiliar words differed. As Table 5 shows, there was a significant difference in accuracy between familiar and target words ($t=12.737$, $p<0.01$), with mean scores of 84.74 ($SD=15.89$) and 39.00 ($SD=15.41$), respectively. This indicates familiar words were those mostly learned by this group, and target words seemed unfamiliar to most of the participants. This confirmed our estimation of learners' vocabulary level with either familiar or target words when we used the four wordlists as criteria for selection.

Table 5. The Independent T-test for Familiar and Target Words in Pretest

Words in pretest	n	Mean	SD	t-value	df	p
Familiar Words	38	84.74	15.89	12.737	74	.000*
Target Words	38	39	15.41			

Note: *significance level $p<0.01$; Total score: 100

As mentioned above, scores for the VKS, i.e., the posttest, were based on learners' self-reported knowledge. In order to compare learners' vocabulary level in the pretest and the posttest, of the 50 target words used in both tests, those for which the learners were able to provide a correct translation or definition were identified as "known" words (words which scored 3-5 points) in both cases. The mean score differences of known words in the pretest and in the posttest were compared using the paired t-test. As is apparent from Table 6, significant overall vocabulary gains ($t=8.849$, $p<.01$) were achieved by learners. With a mean of 39.00 ($SD=15.41$) in the pretest and 49.50 ($SD=17.13$) in the posttest, about one tenth of the words were moved from "not known" (words scoring 1-2 points) to "known".

Table 6. Learners' Overall Vocabulary Gains by Paired t-test

Test	n	Mean	SD	t value	df	p
Pretest	38	39	17.13	8.849	37	.000*
Posttest	38	49.5	15.41			

Note: *significance level $p<.01$; Total score: 100

Cross-comparison of learners' responses in the pretest showed that a total of 10 of the 50 target words were completely unfamiliar to all 38 learners. On the basis of the number of times that each word appeared across the sixteen reading texts, the ten words were grouped into five groups as shown in Table 7. Group One included words that appeared once or twice; Group Two, words that appeared 3-4 times; Group Three, words that appeared 5-6 times; Group Four, words that appeared 7-8 times; and Group Five, words that appeared more than 9 times. Comparisons of the word knowledge gains of these ten words would help us answer the question of how much exposure is needed for successful word learning within the online extensive reading environment.

Table 7. Target Words Completely Unfamiliar to Learners

Group Number	Number of exposures	Words in the group	Word class
Group 1 (1-2 times)	2 times	monopoly	Noun
	1 time	recruitment	Noun
Group 2 (3-4 times)	4 times	startling	Adjective
	4 times	deputy	Adjective
Group 3 (5-6 times)	6 times	calligraphy	Noun
	5 times	epidemic	Adjective
Group 4 (7-8 times)	8 times	faculty	Noun
Group 5 (more than 9 times)	15 times	entrepreneur	Noun

A repeated-measure analysis of variance (ANOVA) was computed to compare the mean scores of the five groups of target words, which differed in the amount of exposure. Results are shown in Table 8.

Table 8. Analysis of Variance for Target Words with Different Amounts of Exposure

Variable	df	SS	MS	F
Group difference in amount of exposure (G)	4	12.663	3.166	3.589
Subjects (S)	37	30.034	0.812	
G X S	148	130.537	0.882	
Total	189	173.234		

The results of the ANOVA showed that a certain degree of word knowledge was gained in all the five groups, including the words that merely appeared once or twice. Also, the amount of vocabulary gain

varied significantly as a function of amount of exposure ($F=3.589, p<.05$), with Group Five, words which appeared more than nine times, achieving the highest mean score of 2.39 and Group One, words that appeared once or twice, having the lowest 1.68. Post hoc analysis using Least Significant Difference (LSD) indicated where the significant differences between groups lay, as shown in Table 9. Except for Group Two, which displayed a surprisingly high mean score (2.37), the mean scores demonstrated a gradual rise in word gains with the increase in amount of exposure. However, none of the mean scores in the five groups reached 3.0 or above (which required the provision of a correct Chinese translation). This indicated that word gains were not sufficient to bring learners from "not known" to "known" scoring categories.

Table 9. Variance for Posttest Scores Among Words with Different Exposure Amount

Group	Mean	SD	Group 1	Group 2	Group 3	Group 4	Group 5
Group 1 (1-2 times)	1.68	0.74		*		*	*
Group 2 (3-4 times)	2.37	0.94	*				
Group 3 (5-6 times)	2.05	1.35					
Group 4 (7-8 times)	2.08	0.67	*				
Group 5 (more than 9 times)	2.39	1.03	*				

Note: * Sig. $p<.05$

Compared with previous studies, the target words in ours might have been intrinsically more difficult. To explore such speculation, we compared the ten target words (those unknown to all participants) to ones in the word lists in the COBUILD Dictionary (Sinclair, 1995), which organizes words into five frequency bands, with band five being the most frequently used and easiest words, and band one the least frequent and most difficult words. A listing of target words in the study and the COBUILD frequency bands to which each word belongs appear in Table 10. As can be seen, except for words in Group Two, *startling* and *deputy*, which belong to band 4, most words were in band 1 or band 2, the least frequent and most difficult bands. This word difficulty difference was also evident in the posttest results. Whereas the mean scores in other word groups showed a gradual rise in word gains with the increase of amount of exposure, group two displayed an unusually high mean score, almost as high as words in group five, the ones that appeared nine or more times. This suggested that words in Group Two could be easier to acquire than others. The inherent low frequency of target words, therefore, might increase the demands on amount of exposure necessary for target words to be acquired in the current study.

Table 10. Target Words and COBUILD Frequency Bands

Group	Amount of exposure	Words in the group	GOBUILD frequency bands
Group 1 (1-2 times)	2 times	monopoly	Band 1
	1 time	recruitment	Band 3
Group 2 (3-4 times)	4 times	startling	Band 2
	4 times	deputy	Band 4
Group 3 (5-6 times)	6 times	calligraphy	Not found
	5 times	epidemic	Band 2
Group 4 (7-8 times)	8 times	faculty	Band 2
Group 5 (more than 9 times)	15 times	entrepreneur	Band 1
	15 times	hypnosis	Band 1
	10 times	administrative	Band 2

Results of the Evaluation Questionnaire

The Evaluation Questionnaire included items addressing four aspects of the delivery of the reading program: system interface design, features fostering vocabulary learning, features of the online reading texts, and motivation for future use. In order to address the second research question, responses to the questionnaire were analyzed. As one can see in Table 11, for questions relating to learners' motivation for future use, 81.6% of the learners expressed their wish to continue to use a similar online reading program in the future. Being able to improve English reading skills (42%) and to facilitate vocabulary learning (33%) were the two main reasons reported by the learners. Only 18.4% of the learners indicated that they would not use similar tools for learning English in the future, the main reason being that they were not used to reading online (51%). Of the seven learners (18.4%) who indicated that they would not use similar online reading programs in the future, four explained that they regarded the online extensive reading syllabus as a helpful tool; however, they already had well-developed extensive reading habits and satisfactory reading materials in print.

Table 11. Learners' Motivation of Future Program Use

Questions	Responses	Percentage
Will I use a similar online extensive reading syllabus in the future?	Yes, I will	81.6%(31/38)
	No, I will not	18.4% (7/38)
The reason why I will use a similar online extensive reading syllabus in the future:	Able to improve reading skills	42% (24/64)
	Able to enhance vocabulary	33% (21/64)
	The articles are interesting	11% (7/64)
	There are various tools fostering vocabulary learning	16% (10/64)
	Others	3% (2/64)
The reasons why I will not use a similar online extensive reading syllabus in the future:	Not used to reading long articles	8% (1/12)
	Not used to online reading	51% (6/12)
	Dislike the fixed set schedules organized by the online extensive reading syllabus	8% (1/12)
	Others	33% (4/12)

As for learners' responses regarding features that foster vocabulary learning in the online reading program, learners rated two of the four features positively with an overall mean score of 3.3 (out of 5.0). Repetitive exposure (mean=3.9) and highlighting with different colors on target words and exposed words (mean=3.8) were considered most helpful; however, the amount of gloss was reportedly least beneficial, with a mean of 2.9. The learners indicated that more words should be glossed to help reading comprehension. Regarding learners' perceptions of the reading texts, they agreed that the text genre was dynamically varied (mean=3.8) and the topics were interesting (mean=3.4). Moreover, they indicated that, compared to selecting reading texts on their own, they preferred the online extensive reading syllabus that had prepared texts beforehand for them (mean=3.7). Nevertheless, the lengthy texts chosen in the program caused the greatest difficulties for most learners. The students felt that their reading comprehension dropped with such long texts. Finally, learners' reactions to the interface design of the

system had a mean of 3.7. Overall, learners were satisfied with the layout of the online extensive reading syllabus.

DISCUSSION

Benefits of the Online Extensive Reading Program for Vocabulary Learning

In this study, we incorporated textual gloss, highlighting, a bilingual Chinese-English concordancer, and high frequency word lists for computerized text selection and sequencing techniques in the design of an online extensive reading syllabus for vocabulary learning purposes. To ensure comprehensible input, the sixteen texts included in the syllabus demonstrated an average target word rate of 1.9%, a percentage just under the optimal range of 2% to 5% suggested by Nation (2001). Most of the text selection techniques were based on Ghadirian's work (2003). However, the distribution in our *Textgrader* syllabus differed greatly from Ghadirian's *TextLadder*, as we added another criterion: the Exposed Word list. This suggests that our goals of providing comprehensible input and repeated exposure of target words were achieved.

The exploratory assessment with pretest-posttest comparison indicates measurable vocabulary learning occurred for the 38 participants, in that the percentage of learners' "known" words increased and "not known" words decreased after twelve weeks of extensive reading online. The learners' improved word knowledge may support the claim that such an online extensive reading syllabus with various learning tools could aid vocabulary learning via extensive reading. Similarly, feedback from the Evaluation Questionnaire also showed learners' overall positive perception of the online reading environment. This may provide positive evidence for utilizing the online extensive reading syllabus to enhance learners' word acquisition through reading.

Learners' Feedback on the Online Extensive Reading Syllabus

After the twelve-week online extensive reading experience, learners' reactions to the syllabus were largely positive. They appeared to approve of the various online vocabulary enhancement features as being effective for vocabulary acquisition. Improved reading and vocabulary abilities were outcomes the learners indicated as the major advantages of the syllabus.

The feedback regarding glossing conflicted with our previous estimation of learner vocabulary level as suggested by the pretest. The pretest results confirmed our familiar words were indeed what had been mostly acquired by learners, compared with target words. Yet, our online tracking program reveals that the learners looked up some familiar words using the concordancer but seldom looked up target words; thus, we suspect that the difficulties might have originated from a common problem—learners' inexperience in extensive reading or look-up strategies. Learners further reported that they were not used to long texts and that they either lost patience or their eyes easily tired from reading online.

Comprehensibility dropped as they increasingly struggled toward the end of the texts. Possibly, instead of using extensive reading strategies, such as contextual guessing, the participants immediately sought help whenever they stumbled across words they did not understand. Furthermore, they exhibited a tendency to make clear every single sentence before proceeding, a practice not encouraged in extensive reading. This intensive reading habit, in turn, makes reading long texts more tiresome and lowers reading comprehension. Thus, although the new word rate had been controlled by sequencing procedures and the pretest results had confirmed our estimation of their vocabulary level, the participants' heavy reliance on glosses suggested that they still had not outgrown habits they acquired in senior high instruction—intensive reading.

Day and Bamford (1998) have pointed out that learners' previous experiences in reading might predispose them unfavorably toward extensive reading. Since intensive reading was the common in-class practice in Taiwan, the learners' reading habits most likely were difficult to adjust even with extensive strategy instruction. One other explanation is that learners' comprehension difficulty might derive from sources

other than vocabulary, such as complicated sentence patterns, their limited ability to grasp main ideas (Nuttall, 2000), or the different contexts and idiomatic nature of familiar words. The question of whether learners' reading difficulty would gradually diminish with an increase in extensive reading experience awaits further exploration.

Amount of Exposure Necessary for Vocabulary Acquisition While Reading

In this study, ten target words identified in the pretest as completely unknown to every learner were divided into five word groups according to their differences in the number of appearance in the sixteen texts. Word gains occurred for all five groups, including words in Group One, which appeared only once or twice. This is consistent with the findings from studies by Nagy et al. (1985, 1987) and Rott (1999) showing that, although improvements were minor, merely one or two exposures to a target word could still contribute to a learner's initial word knowledge. One or two encounters, of course, were not adequate for successful acquisition of more in-depth knowledge. In fact, the results from our study indicated that with scores below 3 on the VKS scale, learners were unable to recall the Chinese meanings of target words successfully even for words in Group Five, which appeared in the texts from 9 to 15 times.

The limited word acquisition in our study adds yet another piece of evidence to previous research suggesting that vocabulary acquisition while one is reading can take place, but the gains may be superficial and unstable (Huckin & Coady, 1999; Hulstijn, 1993; Wesche & Paribakht, 2000). Given our efforts to foster a favorable reading environment for vocabulary acquisition, the learners' performance seems unsatisfactory at first glance in comparison to some previous L2 studies. Four possible factors might have contributed to the difference, namely, the use of authentic material, learners' depth of processing, target word difficulty, and individual differences.

Unlike in Rott (1999), our study was more like ones by Knight (1994) and Paribakht and Wesche (1997), in that we used authentic texts. Paribakht and Wesche (1997) used VKS to assess learners' word gains in reading and found that their learners' knowledge of target words mainly reached only the recognition level, a result similar to the present study. When one's purpose is to grasp information rather than fostering vocabulary learning, it may be more difficult for authentic materials to provide adequate contextual cues conducive to vocabulary acquisition. Therefore, the minimally necessary amount of word exposure for successful acquisition might increase as a consequence of the interplay of inadequate contextual cues and lower inferenceability of word meanings in authentic materials. Distinguishing authentic texts from pre-written texts, such as those in Rott's study, is a factor that could lead to different results.

Another factor influencing word acquisition outcome could have been learners' shallow processing. It seems that textual gloss of Chinese translations and highlighting as preliminary noticing did not encourage the learners to engage in deeper mental processing to form semantic-syntactic relationships. In light of the nature of extensive reading, the participants' processing of texts was presumably meaning-based. Wesche and Paribakht (2000) indicated that, in the context of extensive reading, "[O]nce the immediate communicative need has been met, the learner does not undertake future mental processing of the word" (p. 197). The gloss originally included for ensuring correct target word meaning, although suggested by previous researchers as being beneficial to vocabulary acquisition, may have attenuated the possibility of learners' deeper mental processing. A dilemma existed here, in that precision of word meaning and depth of processing were both desired. A possibly more promising alternative for quality vocabulary acquisition is to use a combination of explicit vocabulary instruction and implicit extensive reading.

As shown in our findings, based on the five frequency bands for words (Sinclair, 1995), the target words in our study were more difficult and, therefore, needed more exposure compared with those in previous studies. Last, it seems that the complex issue of the amount of exposure required for successful vocabulary acquisition through reading cannot be disentangled without considering the impact of possible

individual difference factors, such as effective use of reading strategies. As Pulido (2003) pointed out, the automaticity of reading strategies allows advanced readers to "free up the attentional resources for further vocabulary development" (p. 239). A similar observation was also made by VanPatten et al. (2004), which indicated that while higher frequency of input exposure does facilitate the establishment of form-meaning connections, context specific factors such as learners' readiness, form saliency, and the need for explicit learning may also come into play.

CONCLUSION

The study demonstrated that using word list research and computation processing can select comprehensible texts for a particular group of EFL learners in order to acquire unfamiliar target words through reading. Advanced corpus processing techniques were used to screen and arrange appropriate texts for EFL learners, construct an online reading program, and put it into use with a group of learners. In terms of technology, texts with comprehensible vocabulary were successfully chosen and arranged with the help of various online tools. Pedagogically, word gains occurred, though not to a great extent, and learners' attitudes toward the online extensive reading syllabus were predominantly positive. Nevertheless, the design of the syllabus was based on a rough estimation of the general vocabulary level of a group of learners rather than particular individual learners' needs. Text selection will be more precise if syntactic complexity can be incorporated in the computation processing. In the assessment phase of the study, the use of a control group may yield stronger evidence.

With regard to the measures used for assessing degree of vocabulary acquisition, it should also be noted that although the VKS fits the design of the current study, it is not without limitation. One of the limitations commonly mentioned by researchers is that it assumes a linear progress of vocabulary learning, implying that receptive knowledge will be acquired before productive knowledge (Waring, 2000). Also, the VKS does not explore certain aspects of word knowledge, such as polysemy, collocation, and synonyms. It is clear that vocabulary measures able to address the above limitations still require further research.

Still, several implications may be drawn from the current study. The online extensive reading syllabus could be refined to incorporate substantive corpora and word lists of various levels to accommodate the learning demands of different learners and even those with a different first language. Further, the online extensive reading syllabus appears to be especially useful for incorporating explicit teaching and implicit learning in light of the fact that the syllabus selected by instructors was constructed on the basis of word lists targeting learner groups' English proficiency. The same sets of word lists could be utilized as both in-class direct and explicit instruction and for the online self-access extensive reading practice. Online extensive reading could provide more diverse usage and contexts to stabilize the vocabulary acquisition, a step further along the continuum of vocabulary learning. Pedagogically, we should schedule practice sessions in a way that provides guidance for an extensive reading program. Moreover, online material designers could incorporate on-going reminders on goals and strategies of extensive reading throughout the activity. In sum, with instructor's input in reading strategy training and word instruction, the online extensive reading syllabus can serve as a bridge linking explicit teaching and implicit learning for constructive vocabulary acquisition.

APPENDIX

Target words tested in pretest and posttest

- | | |
|-----------------|-------------|
| 1. entrepreneur | 3. calorie |
| 2. institute | 4. hypnosis |

- | | |
|-------------------|-------------------|
| 5. perform | 28. interview |
| 6. administrative | 29. epidemic |
| 7. immune | 30. inadequate |
| 8. finally | 31. altitude |
| 9. constant | 32. startling |
| 10. psychiatric | 33. deputy |
| 11. session | 34. accommodate |
| 12. virtual | 35. accumulate |
| 13. therapy | 36. embark |
| 14. faculty | 37. initial |
| 15. achievement | 38. precisely |
| 16. concept | 39. import |
| 17. series | 40. inevitably |
| 18. combat | 41. insufficient |
| 19. strain | 42. monopolistic |
| 20. personnel | 43. undertaking |
| 21. calligraphy | 44. sustain |
| 22. clinical | 45. abolish |
| 23. potential | 46. inhibit |
| 24. symbolic | 47. innovative |
| 25. negotiate | 48. recruitment |
| 26. optimistic | 49. sophisticated |
| 27. consumption | 50. eloquently |

NOTES

1. The HSF was constructed by consulting previously developed popular word lists, such as GSL and COBUILD (Sinclair, 1995). It was assumed that college freshmen in the current study should have already learned words from the HSF in high school.

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