

Benefits of Using CALL Vocabulary Programs to Provide Systematic Word Recycling

Scott Miles
(Sogang University)
Chung-Ja Kwon
(Sogang University)

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Considering the large amount of vocabulary that language students need to learn and the limited amount of time available in the classroom, CALL is increasingly seen as an attractive option for learning. One particular advantage of CALL vocabulary instruction is to provide systematic repetition of words, ensuring that learned words are not forgotten. Though previous studies have shown strong support for using systematic recycling of vocabulary words based on repetition schedules, to date no study has determined if CALL vocabulary programs are effective in comparison to traditional vocabulary teaching and study. This study compared five groups with different vocabulary treatment, some with the CALL vocabulary program and others with only classroom instruction or independent study. The results showed that the CALL vocabulary instruction groups dramatically outperformed the non-CALL vocabulary study groups. Use of CALL vocabulary programs with built in repetition schedules is recommended.

I. INTRODUCTION

Considering the large amount of vocabulary that language students need to learn and the limited amount of time available in the classroom, CALL is increasingly seen as an attractive option for learning. Goodfellow (1994), in a article devoted to lexical CALL issues, stated the need for technology to address or at least supplement vocabulary learning in ways a traditional classroom may be limited, such as building up a large vocabulary, giving students control over what words to learn, exercises to promote deeper learning and so on.

In the view of Nation (2001), CALL can provide a key principle of vocabulary instruction which can do much to assist language learning: spaced repetition. Recently there have been several commercial products which have applied this concept to vocabulary programs (see Barranco-Droegge, 2006, for a comprehensive review of current vocabulary training software). Although the specific details vary, most of these programs are primarily built on the principles of spaced repetition. As it is quite difficult to take care of the spaced repetition details in the classroom or in one's independent learning, the computer can keep track of the schedule and deliver vocabulary lessons at the appropriate times to ensure retention.

Such programs are very promising for several reasons. In addition to providing spaced repetition study at the appropriate intervals, these programs can greatly ease the burden of vocabulary teaching on the teacher. We have limited time in our classrooms to cover many skills, and if an effective vocabulary program exists that can be done as homework either on the Internet or in a computer lab, this would free up class time for activities which are harder for students to do on their own.

Despite this relatively new interest of vocabulary programs based on the principles of systematic repetition, little research has been done to measure how effective they are in building up vocabulary knowledge in students. Despite the large number of products that provide these kinds of vocabulary programs, the question as to how well a CALL program for vocabulary learning which provides spaced repetition of vocabulary words has not been addressed.

The purpose of this study was to find out what, if any, benefits in vocabulary learning and retention could be gained by using a vocabulary software program which provides systematic repetition of words for long-term retention. The central research question for this study is as follows: In terms of both receptive and productive use of vocabulary, what are the effects of students using a CALL vocabulary program based on the principles of spaced repetition in comparison with students who study the words by traditional (non-CALL) methods?

II. LITERATURE REVIEW

1. Studies on Spaced Repetition

One of the most robust findings in the area of vocabulary learning is the effectiveness of spaced repetition on learning and long-term word retention. Very few words are learned after the first encounter. The number of repetitions necessary to learn any given word vary greatly and is determined by many factors (Nation, 2001). However, studies in spaced repetition tell us that it is not just how many times a word is encountered, but at what intervals a word is encountered that can also have a major impact on learning and retention.

One major finding in memory research is the advantage of spaced repetition over massed repetition (Baddeley, 1990; Nation, 2001). Massed repetition means spending an uninterrupted period of time rehearsing or studying material that one wishes to learn and remember. For example, a student studying a vocabulary list for 30 minutes but with no later reviews would be considered massed repetition study. Spaced repetition involves spreading out review sessions over an extended period of time with increasingly lengthy intervals between each review session. As a contrast to our example student above, in spaced repetition study, a student might study the vocabulary list for 10 or so minutes, take a break for 5 minutes, study the list again for 10 more minutes, take a second break for an hour or so, and then return and study the list for 10 more minutes. In both examples, the total amount of study time is 30 minutes, but the student using spaced repetition has spread this 30 minutes of study out over a longer period of time.

Studies in memory research (Baddeley, 1990) and vocabulary learning (Bloom and Shuell, 1981; Dempster, 1987) have confirmed that the student in our example following the spaced repetition method would have much better retention of the words than the other student who followed the massed repetition method, even though the total amount of time on task was equal for each learner. This phenomenon is based on the principle that periodic reviews keep new information from being forgotten. With each review, the information is strengthened in the memory.

Pimsleur (1967) developed a repetition schedule based on previous memory research that would potentially maximize the effects of spaced repetition. This is based on the tested principle that most forgetting occurs early on, and thus the need for review sessions is greatest over the first few days. However, with each review the learning and memory of the word gets stronger and thus the intervals between review sessions can get progressively longer.

Table 1 gives Pimsleur's suggested repetition schedule for reviewing vocabulary words. The intervals give a rough estimate of how much time a student should wait before encountering the word again. With each session, the interval gets progressively longer until finally word knowledge is so strong that a student could (theoretically) go for as long as two years without needing another review.

Table 1

Pimsleur's memory schedule (1967)

Study Session	Waiting time before next review session
1	5 seconds
2	25 seconds
3	2 minutes
4	10 minutes
5	1 hour
6	5 hours
7	1 day
8	5 days
9	25 days
10	4 months
11	2 years

Naturally, the schedule is provided more as a rough guideline than a system that needs to be followed precisely (which would be extremely difficult to do). Most CALL vocabulary programs which provide systematic repetition base their scheduling of vocabulary presentation roughly on this guide.

2. Studies on CALL and Vocabulary Learning

There are a number of studies which have examined the use of CALL for vocabulary instruction. In these studies, learners using various forms of CALL were compared to group of learners using traditional classroom activities and paper-based study methods.

Several studies found no advantage for the CALL group over the non-CALL groups (Aust et al, 1993; Bowles, 2004; Duquette, Renie, Laurier, 1998; de la Fuente, 2003; Groot, 2000; Hamerstrom et al, 1985; Kang, 1995; Kanselaar, 1993). Tozcu & Coady (2004) found positive results for the CALL group over the non-CALL group, while McCreesh (1986) found the non-CALL group outperformed the CALL group (see Grgurovic, 2007; and Son, 2001 for a more comprehensive review of CALL-vocabulary studies).

Each of these studies used a variety of different methods, both in the CALL group and in the non-CALL groups. However, none of the studies utilized the principle of spaced repetition and this might explain the lack of positive results for the CALL groups.

To date no studies have compared traditional 'offline' vocabulary instruction and CALL vocabulary learning with spaced repetition built into the program.

III. STUDY DESIGN

1. Subjects

Eight first year English courses in Sogang University were used for this study (N=198). The majority were freshman students, though each group had between 1-4 older students who were repeating the course. Each group had a random mix of majors and roughly equal distribution of males and females (see Treatment Groups below for details).

2. Treatment Groups

There were five groups of students participating in the study.

1) Group A.: CALL Only (N=7)

4 males, 3 females

- 4 humanity majors
- 3 business majors

This group of students only used the CALL vocabulary program (see next section) for the target vocabulary words. No other time was given for the words in class or assigned as other homework. The target words did not appear in any of their coursework materials. Note that the number in this group is far smaller than comparison and control groups. Due to an administrative oversight, we discovered a large number of students in this group encountered the target vocabulary between the first post test and the delayed post test, thus forcing us to exclude them from the study.

2) Group B: CALL + Practice (N=55)

25 females, 30 males

- 27 science majors
- 12 business/economy majors
- 16 humanity majors

This group encountered the words on the CALL vocabulary program in the same way as group B. In addition to CALL vocabulary study, the students also received class instruction devoted to the target vocabulary words, including several types of vocabulary exercises.

This in-class treatment included:

- Hearing an oral definition of the words from the professor
- Making model sentences for half of the words (shared with other students and checked by the professor)
- Cloze exercise practice with the other half of the words

Total amount of instruction time on vocabulary was roughly 90 minutes.

3) Group C: Class Practice (N=57)

28 females, 29 males

- 4 business majors
- 14 mass communication
- 8 humanities majors
- 29 science majors

These students did not use the CALL vocabulary program. However, they received similar in-class treatment of the words as group B. After this instruction, they were told to study the words on their own to prepare for the midterm test.

4) Group D: Independent Study (N= 55)

26 females, 29 males

- 18 business majors
- 9 humanities majors
- 28 science majors

Students in this group were left to study the target words mostly on their own. This group was given a handout with the definitions of the words, a list of common collocations, and several model sentences for each word to help their study (see Appendix II). They were told the midterm tests would cover these words among others.

5) Group E: Control group (N=24)

6 females, 18 males

- 20 business majors
- 3 humanities majors
- 1 communication major

This class was a true control group which had no instruction on the target words.

3. CALL Vocabulary Program

The vocabulary program used for this study was developed by members of the English language department faculty in Sogang University. A website devoted to this program was created (E-Memory Plus, see Appendix I). Students in the study were instructed to go to this website for vocabulary homework 4-5 times a week.

In each study session on the website, students would be presented with 3 new words, followed by various exercises to test and strengthen knowledge of these words. Words from previous sessions which were due to be repeated were also presented along with the new words (see below).

Word presentation included the following information:

- Definition in English
- A translation of the English definition into Korean
- A short Korean translation of the word
- A model sentence (along with a Korean translation of the sentence)
- A list of common collocations (and Korean translations)

The program would then deliver various exercises to quiz the words. A variety of exercise types were presented to increase the efficiency of word learning (Nation, 2001; Stahl & Fairbanks, 1986).

Receptive vocabulary exercises: There were receptive exercises which gave the English word and required the students to select a Korean translation. True/false questions, sorting exercises and listening exercises were also given to develop receptive knowledge.

Productive vocabulary exercises: Several exercises gave the Korean word and required the students to recall and type the English translation. Often, the first 1-2 letters of the English word were given as hints (partial cloze exercises). Students produce the words in isolation and in context sentences.

In addition to providing a variety of vocabulary exercises, the CALL vocabulary program was devised to recycle the words following a spaced repetition schedule based loosely on the Pimsleur schedule referred to in table 1.

The following is an overview of the repetition schedule for a particular word.

Session 1: Introduction of the word (definition, model sentences, etc.). During session 1, four review exercises of the word would follow the word introduction. The first review exercise would appear roughly 10 seconds after the word was initially introduced. The remaining three exercises would appear with intervals of 30 second to 2 minutes.

Session 2: The word is recycled on the following day. Again, four different exercises would be

presented during this session, each with intervals of roughly 1-2 minutes.

Session 3: Session 3 appears one week (6-9 days) after Session 2. During session 3, three exercises are provided, each with intervals of roughly 1-2 minutes.

Session 4: The fourth review day occurs approximately 1 month after Session 3. In this session, students encounter a further three exercises with the word.

The program is designed to continue giving repetitions at later dates and the next review would be scheduled to occur after 3 months. However, for the purposes of this study, the target words only went through the above four sessions.

4. Study Procedure

At the beginning of the semester all groups took a test on 36 target words to determine their current knowledge of the words. For the pre and delayed post tests, receptive and productive knowledge were measured. Of the 36 target words in the study, 24 were selected for the receptive tests and 12 were selected for the productive tests. See Appendix III for details on the tests used for the pre test and delayed post tests.

With the exception of the control group, all groups were told that the midterm tests would cover a sampling of roughly 90 words that students were expected to learn over the first half of the semester. The target words in this study were among those 90 words.

The CALL groups (A: CALL Only and B: CALL+ Practice) began encountering the words in the vocabulary program starting in the second week of the semester. They were told that some of the words encountered on the vocabulary program would be tested during the midterm. The target vocabulary words were not especially identified in any way among the estimated 80-90 words they encountered on E-Memory Plus during this period.

The groups doing in-class practice (Groups B and C) received in-class instruction on and practice with the words during the 6th week of the semester as described earlier. Other vocabulary presented in the class did not receive this type of treatment, but did come up in the reading passages from the class course books.

Group D, which did not use the CALL vocabulary program for the target words nor had any in-class treatment of the words, was given a list of the target vocabulary words during the 5th week of the semester and were instructed to study it for the midterm test. The lists had definitions of the words in English and Korean, and also included common collocations of the words and 1-2 model sentences of each word (see Appendix I)

IV. RESULTS

1. Midterm Test and Results

Due to practical reasons, the entire list of target words was unable to be tested during the midterm period. A sampling of 10 of the target words were incorporated into the midterm tests to give an idea of how well students had prepared for the midterm tests. The words were tested receptively. The control group E was not tested at this time.

Table 2

Midterm Test Results

Group	Average score (10 points possible)
Group A: CALL Only:	9.3
Group B: CALL + Practice:	8.5
Group C: Class practice and independent study:	7.3
Group D: Independent study only:	8.5

The midterm results generally show that all four groups had studied reasonably well for the midterm tests. Only Group C: (in-class practice and independent study) was significantly different from the other groups as shown in Table 2.

As the midterm tests only covered a portion of the target words, it is difficult to make any strong statements about the short term results. It does seem, however, that for short term receptive memory of vocabulary there is little or no significant difference between groups using the CALL vocabulary program in comparison to other study methods. Note, however, that the tests were only of receptive knowledge, not productive knowledge.

2. Delayed Post Tests

After the midterm tests, students did not receive any exposure to the target vocabulary words, and were specifically told that different vocabulary words would be covered in the final test. In the CALL vocabulary program, the target words were in a 2-month waiting period before the next review session and thus were not presented during the remainder of the semester.

Approximately 6 weeks after the midterm tests, the delayed post tests for the target words were given unannounced. The purpose was to see how well the knowledge of the vocabulary words was retained after 6 weeks of having no exposure to the words.

3. Study Results

A comparison of the pre and delayed post tests are given here:

1) Receptive Tests—Pre Test and Delayed Post Test

In the delayed post tests, groups using the CALL vocabulary program had far superior retention of words compared to other groups. The groups using CALL vocabulary (A and B) had more than twice the retention of the Independent study group C and roughly three times the retention of the in-class practice only group D as shown in Table3.

Table 3

Receptive Tests—Pre Test and Delayed Post Test

	pre	Delayed post	Gain*
Group A (CALL only)	14.3	33.7	+19.4 (+40%)
Group B: CALL + class instruction:	13.5	34.4	+20.9 (+44%)
Group C: Independent Study Only	14.1	23.5	+9.4 (+20%)
Group D: In-class study	12.7	19.2	+6.5 (+14%)
Group E: Control group	16.5	20.3	+3.8 (+8%)

*All differences between pre and post tests were significant at .01

ANOVA tests between groups found that differences between groups A and B were not significant (.80). Otherwise, the differences in gains of groups A and B were significant over all the other groups. Differences between groups C and D were also significant (.03). Differences between groups D and E were not significant (.16).

Surprisingly, the control group also made significant progress, though less than any of the other groups. Students in the control group did a fair amount of self-selected reading from graded readers, so it is possible that some of the target words were encountered in this way and picked up incidentally.

2) Productive Tests: Pre Test and Delayed Post Test

Again, as Table 4 shows, the CALL vocabulary groups were far ahead of the non-CALL groups.

The fact that the CALL vocabulary program used in this study provided productive exercises which required students to recall words from memory perhaps plays the biggest factor in these results. An ANOVA failed to show a statistically significant difference between groups A and B, but the differences between groups A and B and all the groups were significant.

Unlike the results in the receptive tests, the 'in-class study' group D is ahead of the independent study group C. This can be interpreted as a direct result of the types of exercises done in class which allowed students to create sentences and use the words. The ANOVA test failed to show a significant difference among these groups, but the results were close to statistical significance (.10).

Table 4

Productive Tests: Pre Test and Delayed Post Test

	pre	Delayed post	Gain*
Group A (CALL only)	9	23.4	+14.4 (+40%)
Group B: CALL + class instruction:	11.5	27.5	+16 (+44%)
Group C: Independent Study Only	12	15	+3(+9%) (sig. .05)
Group D: In-class study	11	17.5	+6.5 (+18%)
Group E: Control group	14	16	+2 (+5%) (sig. .08)

All gains significant at .01 unless noted otherwise

The non-CALL groups made very little progress in productive use of the vocabulary. Note that their gains barely exceed those of the control group, which did not study the words directly at all. An ANOVA test failed to find a statistically significant difference between the non-CALL experimental groups (C and D) and the control group E, though group D gains were just short of statistical significance (.06).

The lack of progress in productive use of vocabulary in the non-CALL groups (C and D) is indicative of typical rote memory learning methods that most students use when left on their own to study vocabulary. Although memorizing words from a list the night before a test may work well for tests of receptive vocabulary knowledge, they seem to do little to develop long term retention and the productive use of the words.

3) Time on Task

One aspect of the study methodology that should be addressed is time on task. If students in one study method spend a significant amount of extra time on vocabulary tasks, then gains may be due more to time on task rather than the methodology of the task itself.

Roughly 90 minutes of classroom instruction time was devoted to vocabulary instruction of the target words in the study for groups B and C. This equates to roughly 2:30 minutes of instruction and practice per target word.

For the CALL vocabulary groups (A and B), we programmed the site to provide data on how much time students took per exercise of every target word. Students using the vocabulary program would encounter each target word in 4 different sessions. The average time spent studying on target word on the program totaled slightly less than 4 minutes (3:53).

Thus, students using the vocabulary program had a little more than 1 minute additional time with each word. The fact that group B, which had CALL instruction *and* in-class practice, did not make significant gains over group A, which only had CALL instruction, indicates that this difference of total time itself is very unlikely to have had much of an impact.

V. CONCLUSIONS

For both receptive and productive use of vocabulary, students using the CALL vocabulary system with the benefits of spaced repetition presentation far out-performed groups which followed more conventional methods of study. This confirms previous studies showing the benefits of studying vocabulary via spaced repetition rather than massed repetition practice. These results suggest rather strongly that CALL applications for vocabulary study can greatly assist students in learning, retaining and using vocabulary in comparison to the conventional study methods students often use.

The CALL vocabulary system used in this study also resulted in considerable gains in productive vocabulary use. This is most likely due to the nature of some of the exercises on the program which demand students recall and produce the vocabulary words. Students who study vocabulary on their own are far more likely just to test their word knowledge receptively through rote memorization of translations and this does little to develop productive use of vocabulary.

The addition of in-class presentation and exercises on vocabulary did have a beneficial effect. However, this effect was not particularly large. Strong claims cannot be made for group A which had only CALL vocabulary instruction, as the sample size is rather small. Nonetheless there is little evidence that the in-class practice of words added much benefit. Indeed, the differences between groups C and D confirm that the time spent in class working on vocabulary had little impact. It could be concluded that since the benefits of adding in-class work to vocabulary words are small, class time might be better spent on other skills. However, a strong argument can also be made for using class time to focus on aspects of vocabulary learning which a computerized vocabulary program can not cover well (i.e. pronunciation, fluency activities in speaking, etc.).

In addition to showing the benefits of using CALL vocabulary programs, this study also reveals how poorly students are learning vocabulary when left on their own. The productive gains on target vocabulary were not statistically different than the control group which had no explicit study of the words. Gains in receptive knowledge were significant, but not particularly impressive. One strong advantage of using CALL vocabulary programs is that it prevents students from resorting to study habits which only result in short-term learning.

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I. Website and software used in study

McCarthy, A & Miles, S. (2006). *E-Memory Plus*. Praxis Ed. <http://ememoryplus.com/> (2007/11/27)

II. Example of vocabulary information given to Group C

Adjacent

Definition	be next to or near something (formal)
Translation	어떤 것의 옆에, 가까이에 있는, 인접한
Short translation	인접한 adjacent area: 인접 지역 adjacent cell (in a spreadsheet): 옆 칸 adjacent site: 근접한 장소 adjacent room: 옆 방
Collocations and example sentences	adjacent to something: 어떤 것의 옆에 They work in adjacent buildings.: 그들은 바로 옆 건물에서 일한다. They lived in a house adjacent to the railway.: 그들은 철도 옆 집에서 살았다.

III. Pre and Delayed Post Tests

For the pre and delayed post tests, receptive and productive knowledge were measured. Of the 36 target words in the study, 24 were selected for the receptive tests and 12 were selected for the productive tests.

III-1. Receptive Knowledge Test

For measures of receptive knowledge, 24 of the words were tested in a simple L2-L1 translation task, in which students were asked to provide appropriate Korean translations for the English words.

Scoring:

Each word translated correctly was scored 2 points. Translations which were not exactly correct but clearly indicated that the student had some idea of the correct word meaning were given partial points (1 point).

For reliability concerns, a Korean professor of English was solicited to correct all of the pre and delayed post tests. She was entrusted to judge the accuracy of the translations. To ensure consistency, she was not told which tests were the pretests and which were the delayed post tests.

III-2 Productive Vocabulary Test

This test of 12 words focused on the students' ability to recall and use the words properly in a high context sentence.

Example:

I don't understand what you wrote here. Can you cla_____ this for me?

Many people lost their jobs during the economic cri_____ in 1997.

To determine the level of word mastery, each word was worth 3 points:

- 3 points = correct word was recalled, spelled correctly, and used with proper grammar.
- 2 points = the correct word was recalled but with minor spelling errors and/or minor grammar mistakes.
Example: spelling mistakes such as 'percieve', or grammar mistakes such as "She didn't perceived that there was any difference."
- 1 point = Some evidence that they knew what word was supposed to be produced, but had major spelling and/or grammar errors. *Example: spelling mistakes such as 'perseev' or grammar mistakes such as "She didn't perception that there was any difference."*

For reliability, one researcher scored all of the productive vocabulary tests. To prevent possible scoring bias, the tests were not identified as being pre or post tests, nor was there any indication of which groups the tests belonged to.

III-3 Pre test and delayed post test

Vocabulary Test: Name: _____ Student Number: _____

1) Write the Korean translation next to each word

accommodate _____	coherent _____	empirical _____
adjacent _____	consistent _____	explicit _____
advocate _____	contrast _____	fluctuate _____
allocate _____	controversy _____	fundamental _____
ambiguous _____	cooperate _____	hierarchy _____
amend _____	criteria _____	manipulate _____
arbitrary _____	deviate _____	relatively _____
bulk _____	emphasize _____	revise _____

2) Finish the incomplete word in each sentence. Be careful with spelling.

- 1 The study is not finished yet, but the prel _____ results look good.
2. The school ad _____ decided to hire 15 new teachers this year.
3. I ass _____ the meeting would finish at 7, but it didn't end until 9.
4. I don't understand what you wrote here. Can you cla _____ this for me?
5. Many people lost their jobs during the economic cri _____ in 1997.
6. Does this building have any computer fac _____ for the students?
7. Scientists are conducting re _____ on ways to cure cancer.
8. Her personality is so uni _____! I've never met anyone like her!
9. I can't con _____ on my studies if there is a lot of noise.
10. This story isn't accu _____. What really happened is quite different.
11. This final test is com _____. It will cover everything we did in class over the entire semester.
12. Are you happy to give people money? Or are you rel _____ to do that?