Using different types of dictionaries for improving EFL reading comprehension and vocabulary learning

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This study investigated the effects of monolingual book dictionaries, popup dictionaries, and type-in dictionaries on improving reading comprehension and vocabulary learning in an EFL program. An experimental design involving four groups and a post-test was chosen for the experiment: (1) pop-up dictionary (experimental group 1); (2) type-in dictionary (experimental group 2); (3) book dictionary (experimental group 3); and (4) no dictionary aid (control group). Following training on different types of paper and electronic dictionaries, post-tests were given to the participants. Findings showed differential effects produced by the three treatments compared with the control group. Results indicated that the pop-up dictionary group had the shortest average vocabulary searching time, vocabulary and text reading time, and more "look-ups" (p<.0001) than other dictionary groups. In addition, ANOVA analyses showed that text reading time was significantly longer for the book dictionary group. Reading comprehension and vocabulary learning were higher for the pop-up dictionary group than for other dictionary groups. Furthermore, survey data indicated that pop-up dictionary participants had slightly more positive attitudes toward dictionary use than the type-in group, and both had significantly more positive attitudes than book dictionary participants. Discussion of findings according to cognitive load theory followed, eventually leading to recommendations for teaching and research.

Keywords: e-dictionaries; reading comprehension; vocabulary learning; cognitive load

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Introduction

In reading and/or writing research dealing with second/foreign language learning, the use of dictionaries has been a focus of significant recent research interest (Yoshii, 2006). Research has focused on dictionary use in translational writing and reading, comparing and contrasting paper dictionaries with electronic ones, or monolingual and bilingual dictionaries (Bogaards, 1994; Bogaards et al., 1996; Fageeh & Mekheimer, 2011, Mekheimer & Aldosari, 2010; Mekheimer, 2012, Piotrowski, 1989). In addition, a growing body of research has been carried out to examine the pedagogical uses of dictionaries with regard to factors such as language learning aptitude, motivation, attitudes, and the use of dictionaries as a learning tool for the development of general language skills (e.g. Béjoint & Moulin, 1987; Christianson, 1997; Hartmann, 1994; Leffa, 1992, Mekheimer, 2012). However, prior research suffers from some kind of ambiguity in explaining the effectiveness of dictionaries as learning tools.

In Middle Eastern contexts, some studies showed that Arab students encounter problems while using different types of dictionaries, which vary in difficulty levels (Al-Darayseh, 2013). For example, Dwaik (2015) showed that digital dictionaries can be more useful than traditional dictionaries, but this depends on how efficient the students are at looking up words so as to use them to their maximum advantage. In addition, students' habits of using different types of dictionaries could exercise differential effects on students' use of dictionaries (El-Sayed & Siddiek, 2013). Furthermore, some studies showed the priority of monolingual dictionaries over bilingual dictionaries in inducing better vocabulary learning (Ahangari & Dogolsara, 2015). In this vein, Coady, (1997) reported that:

> Several studies found that many adult L2 learners systematically misinterpret [English monolingual] dictionary entries and take much more time compared to non-dictionary users with limited advantage gained. (Coady, 1997, p. 286)

However, much of the previous research gives limited attention to the use of different types of dictionaries over an extended learning period as distinct from their use in a single language test, or a relatively short study period. Regarding the importance of potential uses of different types of dictionaries in language studies, it seems equally important to investigate the effectiveness of different types of book versus digital dictionaries in second/foreign language programs.

Despite the fact that there is prior research indicating possible benefits of language learning from extended use of dictionaries in classrooms, a comparison of the effects of different types of dictionaries is absent in most current investigations that tackled computer-mediated lexicography research (Bruton, 2007; Knight, 1994; Kubota, 2001; Liu & Lin, 2011; Mekheimer, 2012; Uzawa, 1996). Several models of writing (Christianson, 1997) and reading (Krashen, 1989) ignore dictionary use as a tool for vocabulary learning while writing and reading although the role of glossing in particular has been very much the focus of research on incidental vocabulary learning from reading and writing (Abraham, 2008, Bruton, 2007; Huang, Chern & Lin, 2009, Hulstijn, 2001; Hulstijn, Hollander, & Greidanus, 1996; Yoshii, 2006). Liu & Lin (2011) reported on variations in comprehension and vocabulary performance from use of dictionaries with medium effects on comprehension and larger effects on incidental vocabulary learning.

Laufer (2000), based on a variety of studies, reported that learners who always consult **124** their dictionaries are apt to acquire more vocabulary than their peers who read without

consulting dictionaries for words they don't know. The theory proposed by Laufer is that in the absence of dictionaries, readers can ascertain the meanings of unknown words by guessing and ignoring unfamiliar vocabulary. In this case, new vocabulary is likely to be ignored or forgotten and learners whose methods of deduction are flawed are likely to either retain incorrectly guessed vocabulary or retain nothing at all (Laufer, 1997; 2000). However, when learners exert effort in looking up new words in their dictionaries, this vocabulary is more likely to be remembered than what is inferred from context (Luppesku & Day, 1993; Knight, 1994; Mondria 1993), or explained when meanings are provided directly by teachers (Hulstijn, Hollander and Greidanus, 1996). One possible explanation for the retention of new words located in dictionaries is that learners pay more attention and make greater mental effort to infer and interpret meanings of new look-ups, which helps increase their lexical processing (Zhiliang, 2008). This could explain why online dictionaries are most often consulted when learners are creating and/or deciphering digitally mediated written texts (Jin & Deifell, 2013).

On the other hand, taking time during the reading of a passage to consult a dictionary could distract from comprehension of the passage as attention is focussed on finding the word and seeking to understand its meaning. This effect would be expected to be minimized with a pop-up dictionary where the process is simple and fast, and to be maximized for paper dictionaries where the word has to be retained in working memory; while a separated search of the dictionary is carried out to find the meaning of the word. The effects of this separate exercise could be reduced over time for students in language classes as they become more familiar with and more efficient in such paper dictionary searches.

It is important to note the considerable distinction between benefits for comprehension of the meaning of a passage in a text which may require a dictionary definition of a particular word to understand the passage, and possible retention of that new term in long term memory as an increase in vocabulary. Rapid and easy use of a dictionary can reduce cognitive load in a similar way to integrating glossaries into a reading passage, and as a result, afford greater comprehension. Incidental vocabulary acquisition could be enhanced by simple and fast clarification of word meaning in the context of a longer passage. Alternatively, Zhiliang (2008) posits that a more extensive dictionary search could also increase incidental vocabulary acquisition with the possibility of some negative consequences for broader passage comprehension. The cognitive load associated with dictionary usage will decrease with experience and skill in dictionary usage over a longer study period, and would be expected to result in both improved comprehension and incidental vocabulary acquisition.

The ambiguity of the results of the dictionary usage studies referred to above could partly be explained by studies of single or short-term studies of the effects stemming from different types of dictionaries. To address this issue the present study investigates the effects on students' comprehension, attitudes and incidental vocabulary acquisition after a full semester of study using pop-up, type in or paper dictionaries, or no dictionaries over a full semester of study.

A review of recent research on the use of dictionaries including associated cognitive load associated with their use is provided below.

Background research

Dictionaries have been recognised as "the most common type of reading aid" (Liu & Lin, 2011, p. 373) employed for looking up unfamiliar word(s) that interfere with reading comprehension. Moreover, unfamiliar word(s) that cannot be guessed from context has sparked increased attention in relation to the approximate benefits of different types of dictionaries, particularly, with the increasing use of online reading and availability of computer mediated aids.

Although reading texts in reading and comprehension courses are intended to develop reading comprehension strategies and consulting a dictionary can be very helpful in facilitating comprehension and facilitate incidental vocabulary learning, it can also interfere with that process (Hulstijn, et al. 1996; Krashen, 1982, 1989; Laufer & Hulstijn, 2001; Nation & Carter, 1989; O'Keeffe, McCarthy & Carter, 2007, Rott, 1999; 2000; Yeung, Jin & Sweller, 1997).

The possibility of dictionary consultation facilitating or being a hindrance to reading comprehension or incidental vocabulary learning can be explained from the perspective of the *cognitive load theory*. The cognitive load theory postulates that there are three types of cognitive loads that have an impact on learning performance:

1. Extraneous cognitive load: this refers to irrelevant information limiting the capacity of the working memory. This load is generated by the presentation method of instruction, and attributable to the design of the instructional materials and the mode in which new information is presented to learners in an educational setting. An example of extraneous cognitive load occurs when there are two possible ways to present new vocabulary; e.g., using a paper-based, bilingual dictionary or an online pop-up dictionary. In this instance, the efficiency of the pop-up dictionary is preferred as it does not unduly load the learner with unnecessary information, which is extraneous.
2. Intrinsic cognitive load: This term refers to the basic memory capacity for holding task elements in the working memory for simultaneous cognitive processes. This load is defined by the inherent level of difficulty associated with a specific instructional topic.
3. Germane cognitive load: This term refers to the efforts on the part of the learner to facilitate learning tasks. It is the load devoted to the processing, construction and automation of schemas.

Paas & Van Merriënboer (1993) devised a construct known as relative condition efficiency to assist researchers in measuring cognitive load by calculating the mean scores of students in comparative instructional conditions, and subsequently relate mental effort ratings to performance scores through running a one-way analysis of variance (ANOVA). In order to analyse the relative efficiency of the intervention, a computational method was developed which combines mental effort expended (e.g., testing effort) and performance (e.g., test scores) during assessment (pre-testing and post-testing) by standardizing raw performance and mental effort data z-scores utilizing the equation:

$$E = \frac{z_{Performance} - z_{Testing\_effort}}{\sqrt{2}}$$

In this equation, mental effort is related to performance in the context of instructional efficiency. High instructional efficiency is achieved when high task performance is attained in association with low mental effort and vice versa.

According to several researchers (Liu & Lin, 2011, Plass, et al., 2003; Paas, et al., 2004; Sweller, 2010; Yeung, et al., 1997; Yoshii, 2006), the method and format of gloss presentation can either reduce or increase cognitive loads associated with the learning tasks, thereby facilitating or hindering task learning performance. For instance, integrating glossaries into the reading passages (integrated format) can potentially decrease extraneous cognitive loads, increase memory, and enhance relevant cognitive loads; consequently leading to better reading comprehension. In addition, the use of pictorial cues, animation, multimedia, lexical annotations and glosses (or a multimodal method of word presentation) were found to be conducive to enhanced incidental vocabulary acquisition (AbuSeileek, 2011, Acha, 2009; Peters, 2007; Yoshii, 2006). Computer-mediated dictionaries, easily accessible by EFL learners (Aldosari & Mekheimer, 2010), can provide a facilitative springboard for reading comprehension and vocabulary learning because of the ease with which the meanings of lexical items can be captured. Liu & Lin (2011) observed:

> It is possible that the convenience afforded by computer-mediated aids could potentially free up more cognitive resources for comprehension. The other apparent advantage of the advanced aids is the learning opportunities associated with their use. Due to the convenience, readers might be more willing to use computer-mediated dictionaries, thereby exposing themselves to more words. (p. 374)

Because of this convenience using digital dictionaries, different types of e-dictionaries are recommended for use, especially when reading online, since immediate feedback from e-dictionaries while reading online facilitates vocabulary acquisition more favourably (Zhiliang, 2008). Commonly suggested for use in online reading by teachers and researchers are type-in online dictionaries and pop-up electronic dictionaries such as those installed on the Windows operating system. These are readily available for use with a move of a cursor or a "double-click on any given word to bring up a definition" (Liu & Lin, 2011, p. 373). The uses of these types of electronic dictionaries have benefits and drawbacks (See Liu & Lin, 2011). For example, there are arguments against the casual use of pop-up dictionaries, which are considered to be ineffective for long-term retention of vocabulary. These arguments relate to the effect of cognitive load and effective manipulation of the working memory for rehearsing, recalling and retaining new meanings. (e.g., Anderson, 1995; Hulstijn, 2001; Barrouillet, Bernardin, Vergauwe, and Camos, 2007; Barrouillet & Camos, 2010; Camos & Barrouillet, 2009; Craik & Lockhart, 1972; Kim, Byun, Lee, Gaillard & Theodore, 2011, Ward, Tan & Grenfell-Essam, 2010).

Research findings dealing with different types of dictionaries differed on the basis of learners' proficiency level. Some of this research revealed that low, non-significant correlations existed between time spent on reading English and English reading comprehension for low-proficiency learners, while correlations for high-proficiency learners were more substantial and significant (Hulstijn, et al., 1996; Liu & Lin, 2011; Pichette, 2005).

It is clear from this review, that there are differing conclusions about the effects of different types of dictionaries on comprehension and vocabulary in second language learning. Additionally it remains unclear whether differences may relate to the use of dictionaries in a single reading or test situation as in Liu & Lin (2011), or to development of skills and vocabulary over an extended learning period. It is possible for example that consistent use of paper based dictionaries or type-in dictionaries over a period of time may reduce cognitive load associated with their use and that the differential benefits found in comprehension or vocabulary for pop-up dictionaries may not be achieved or, if so, to a lesser extent. It is **127**

possible that reduction in cognitive load associated with paper based or type-in dictionaries, as a result of extended use, might result in greater vocabulary acquisition as a consequence of the greater attention given to seeking the meaning of particular words without negative effect on comprehension.

Use of a pop-up dictionary requires almost no special effort and would minimize cognitive load. Use of a book or paper based dictionary would involve more substantial time and cognitive load regardless of experience with its use. However, a type-in dictionary would involve fairly minor effort in an on-line reading situation but still some special attention to seeking word meaning. Accordingly, it was anticipated that use of a type-in dictionary could result in better vocabulary acquisition with limited or no negative effects on comprehension. Nevertheless, there is little empirical research data on this question and it was considered desirable to test this conclusion.

In their study, Liu & Lin considered the differences in reading processes and comprehension and vocabulary acquisition for pop-up, type-in and book dictionaries with comparisons made with a control group of non-dictionary users. They found that willingness to use a dictionary as measured by frequency of consultation was the greatest for pop-up dictionaries and the lowest for book dictionaries. In addition, it was found that the most effort in finding target words as measured by vocabulary searching time was expended for the book dictionaries followed by type-in and pop-up dictionaries. Reader comprehension and vocabulary acquisition were better for all dictionary users than for a control group that did not use dictionaries, but the differences for users of different dictionary types were not significant.

As noted, the study by Liu & Lin involved a single reading and testing exercise and did not make use of dictionary types over an extended period. Therefore, it did not take into account the possible effects of practice on reducing distraction from comprehension while seeking the meaning of a word in a type-in dictionary. Liu & Lin further elaborated that although research has been carried out in a variety of settings with learners from different native language backgrounds limited attention to the possible effects of use of different dictionaries over a lengthy training period hasn't occurred.

Answers to the following research questions to determine whether similar results would be found after an extended period of study using book, type-in or pop-up dictionaries will be studied. Data was extrapolated from a population in the Saudi Arabian context learning English as a foreign language. The results should be relevant for foreign language instruction in any location where the target language is not widely used in the local population.

1. Which type of dictionary can lead to the most efficient dictionary use, reading comprehension and vocabulary learning?
2. Which type of dictionary would lead to the most positive evaluation by English as a foreign language readers undertaking a reading task?
3. Which type of dictionary can result in better vocabulary learning and better reading comprehension?

Hypotheses

The following hypotheses were developed on the basis of this literature review and tested through the processes described below.

1. Participants using the book dictionary will exert more effort (measured as time taken) in finding target words than those using a type-in dictionary or a pop-up dictionary,

and those using a type-in dictionary will exert more effort than those using a pop-up dictionary. This hypothesis is consistent with research reports reviewed above and its validity for this group of students is important for considering theory relating to the relative effectiveness of different dictionary types for attitude, comprehension and incidental vocabulary acquisition.

2. The attitude of participants using dictionaries will vary consistently with the amount of time taken in using them. That is the most positive attitude will be for those using the pop-up dictionary followed by the type-in dictionary and then the book dictionary. This would be consistent with previous research indicating greater frequency of use as a reflection of positive attitudes for pop-up dictionaries.

3. Participants using the type-in dictionary will learn more vocabulary than those using the pop-up dictionary or the book dictionary. This is a predicted result based on the cognitive load theory, but research results have differed in past research and it is important to investigate this expectation in a study involving an extended period of study in which learners would become increasingly skilled in the use of dictionaries.

4. Participants using the pop-up dictionary will achieve better comprehension than those using either the type-in dictionary or the book dictionary. This is predicted as a result of earlier studies due to minimal cognitive load and avoidance of distractions due to more elaborate dictionary consultations.

Methodology

Method

An experimental method involving a post-test and control group design for four equal groups of students was employed during the first semester of the academic year 2010. Four groups were assigned to the experiment; Experimental Group 1 using a pop-up dictionary; Experimental Group 2 using a type-in dictionary; Experimental Group 3 using a conventional book dictionary; and Group 4 with no dictionary aid to serve as a control group.

Groups 1 and 2, the pop-up dictionary group and the type-in online dictionary group, used the computer screen to do all dictionary lookups. Group 1 used an application that required the reader to double click on a target word, which resulted in a definition of the word appearing on the screen. Group 2 used the online dictionary available via http://dictionary.reference.com which required them to double click to open a type-in window into which they typed in the word concerned to access a definition. Access to applications was programmed into the laptop computers used by the students in these groups in class and for use elsewhere. Group 3, the book dictionary group, used a paper dictionary, the Oxford Advanced Learner's Dictionary (5th edition, composed of 1428 pages, which was made available in paperback to all students in this group). The control group had access only to the reading texts without any additional dictionary information available.

Participants

The participants consisted of 140 students enrolled in the English department, Faculty of Languages & Translation, King Khalid University, who were enrolled in Reading II. The students were randomly assigned to four groups of 35 students. All participants were males, aged between 17 and 19 years, whose native language is Arabic. The students all had **129**

similar backgrounds through their English language programs in secondary school and the random assignment to the four treatment groups meant that they could be considered equivalent in their initial skill levels.

However, to reaffirm any background assumptions all students were given a TOEFL test at the beginning of the course to assess their language proficiency. Analysis of variance (ANOVA) was used to verify the comparability of the groups and test for any differences between them on the initial language tests and no significant differences were found. The mean score for all the groups was in the range of 567 to 580. Group 1, mean score of 572, Group 2, mean score of 567, Group 3, mean score of 580 and Group 4, mean score of 576. As a further means of verifying the equivalence of the groups, the researcher ascertained the socio-economic level for each student in the study population using Kuppuswany's socioeconomic status scale (the updated version of 2005); which considers information about the education and occupation of the head of the family and per capita income per month. All groups were from the lower middle class (11-15 on the scale) and no significant differences between the groups on this scale were found.

Table 1 shows the mean scores of the four groups on the initial TOEFL test and the Kuppuswany scale.

Table 1. Results of initial TOEFL test and Kuppuswany scale for the groups in the study

Group	TOEFL test		Kuppuswany scale	
	Mean	SD	Mean	SD
Group 1 Pop-Up	572	18.29	13.21	2.13
Group 2 Type-in	567	16.93	12.98	1.99
Group 3 Book Dictionary	580	17 92	13.08	1.86
Group 3 Control	576	18.11	12.89	2.05

All four groups were taught by the same instructor, the researcher in this study, to avoid variability influences on the effects of the different conditions. Reading material used was the same for all groups and the same time was allocated in class for reading sessions for all groups. Other than reading tasks, the same forms of instruction were used for all four groups. The three groups using dictionaries were issued with the type of dictionary for their group and were given initial training in the effective use of that form of dictionary at the beginning of the course.

Afterward they were encouraged to use that dictionary regularly during reading sessions in class, in reading exercises at home, and in other situations. The students in all groups were asked to provide brief weekly reports on what reading they had done at home and those in the dictionary groups to confirm that they had been referring to in their dictionary during out of class reading activities. The students in all the groups were informed at the beginning of the course that they were involved in a comparative study involving different approaches to language instruction and requested not to discuss their class and out of class reading activities with students from other classes. As part of their weekly reports they were asked to confirm that they had not done so.

The study was designed to assess the effects of using the different dictionaries for the full semester and there were no formal tests of comprehension or incidental vocabulary

acquisition during the semester.

Instruments

Reading material & vocabulary learning. The researcher used the assigned Well-Read II textbook in course, which the students were enrolled. Selected reading passages from the book were saved to all laptops in the college computer labs, with a Safari 5.0.3 browser for Windows installed in order to enable students to read the text, and students in groups 1 and 2 to gain access to the type-in or pop-up dictionary aids according to the group to which they were assigned. Personal computers used by students in these groups were programmed to provide access to these aids for use at home or elsewhere.

Tests. Two tests, one for vocabulary, and the other for assessing reading comprehension, were developed based on a selected reading passage, which they had not previously read.

The vocabulary test

An English vocabulary multiple-choice test with four options was developed comprising of 25 items drawn from the reading text. In each case students were asked to select the correct meaning of a word in the target language from a list of four possible matching items. These words were identified by the faculty members responsible for the course. The random selection of students into different groups combined with verification of their comparability through the TOEFL test and the Kuppuswany scale was considered adequate to indicate equivalent levels of initial understanding of vocabulary in the different groups. Accordingly, a pre-test was not administered. The items were drawn from the final reading text and from other reading tasks used in class for all the groups during the semester. There was no assessment of the extent to which particular words had been looked up in the classroom sessions.

The use of a test containing a 25 vocabulary items was considered an adequate sample of vocabulary acquisition and was comparable to other studies reviewed in the literature survey. (E.g.,Luppesku & Day, 1993; Knight, 1994; Mondria 1993,Hulstijn, Hollander and Greidanus, 1996)

The test was marked out of 100, with four points per item. The test was piloted with a sample of other students with similar background to the participants in this study. The pilot test bore a difficulty factor of 0.5, which was considered an optimal level of difficulty for the purposes of the study. The inter-reliability of the vocabulary test on the Kudar-Richardson formula 20 was .84.

The reading comprehension test

A test of 30 multiple-choice items designed for checking comprehension of a reading passage excerpted from the book not previously studied by the students was developed by the researcher, and assessed by three other instructors in the department for inter-rater validity. The reading passage included two articles *Alexander Fleming: Discover of "Miracle Drug" Penicillin*, and *Echinacea: It Works, Oops, It Works Not*. The articles were of medium of difficulty with a total of 695 words. Inter-rater reliability was assessed for difficulty alongside the vocabulary test to ensure that students in different groups were receiving equivalent testing assessments. This test was administered to the same pilot study sample used for the vocabulary test. The test was assessed for item discrimination and reliability; and items that had too high or too low scores were taken away (thus 5 items were eliminated). Students received 4 points for each correct answer and 0 points for each incorrect **131**

answer with a maximum total score on the test of 100. The reliability estimate for internal consistency of the reading test was 0.81 based on Kuder-Richardson formula 20.

Vocabulary search willingness and effort questionnaire. A 5-item Likert scale questionnaire was designed in three versions addressing the three research treatments (excluding the control group which had no dictionary) in order to collect qualitative information from the participants in each group about their attitude towards the use of a dictionary after the study was completed. Together with data about average vocabulary search time, average vocabulary reading time, frequency of use, and average text reading time, collected via the Safari browser, qualitative information uncovered helped in assessing the effectiveness of each form of dictionary use.

Measures of efficiency of dictionary use

Efficiency was checked in the final test against the criteria of vocabulary search time, vocabulary reading time, frequency of dictionary consultation, and text reading time. The processes followed were the same as those used by Liu & Lin (2011) and assistance in analysing camera archives was provided by two research assistants with previous experience in teaching this course.

Vocabulary search time was calculated for the three groups using the paper and digital dictionaries as follows:

For group 1 using a pop up dictionary it was the time taken by readers to double click their mouse to seek a definition.

For group 2 using a type-in dictionary it was the time taken from the initial double clicking (to open a type-in window) until the reader had typed in the desired word and hit the enter key to retrieve the definition.

For group 3 using the book dictionary to calculate times for search and reading times and frequency of dictionary use was recorded and, as such, recordings analysed by the researcher. Three cameras were used to ensure coverage of the group. During the semester prior to the final testing, the use of these cameras was trialled to ensure that observations of student behaviour in accessing dictionaries could effectively be monitored. For this group, search time began when students opened the dictionary and pointed to the word to be defined. To check these times, each student in this group was issued with a timer activated by a button, which the student pressed when beginning to search for a word, a second time when the word was found, and again when the search was completed and reading recommenced. The timers recorded the number of searches and the time taken to find the words and the time taken to read and understand the term concerned.

Vocabulary reading time was calculated for these three groups as follows:

For group 1 using a pop up dictionary, it was the time between when the definition window appeared until the reader closed it.

For group 2 using a type-in dictionary, it was the time between when the enter key was triggered to retrieve the definition until the reader closed the definition window.

For group 3 using a traditional dictionary, students were asked to place their finger on the word while reading. Reading time was the time between when their finger was placed on the word and the dictionary was closed. As noted above, the times worked out by the researcher when viewing the camera archives were checked against and confirmed by the timers used by the students.

For groups 1 and 2, detailed data for times taken for search and reading time and the number of times the dictionaries were consulted were automatically logged into the students' computers.

For group 3, the times for each student were recorded by the researcher following analysis of the archives. For all four groups, students commenced reading at a specific time when requested by the instructor to do so and to record the time shown on a wall clock at the front of the class in minutes and seconds when they finished the reading assignment. The researcher then calculated the time taken by each student and the mean time in seconds for each group.

Procedures

At the beginning of the course, the students were randomly assigned to the four groups described above. In the first session, they completed the TOEFL test and completed the Kuppuswany scale. After this, members of groups 1, 2, and 3 were given general information about the course and guided on how to use their respective type of dictionary. Members of group 4, the control group, were given only the general course information.

During the 16 week course the same teaching strategies were used for all four groups, the only difference in approach being the availability of dictionaries for use by the students in groups 1, 2, and 3 during periods of assigned reading and in out of class reading. For group 4, which had no dictionary access, the instructor presented vocabulary at the start of each session then read the passages for the students or asked some of them to read them, followed by drill and practice exercises. Instruction in the reading classes, in the four groups continued for one semester (16 weeks, three hours per week). One week after the termination of the project, all participants in the four conditions were tested using the same tests and the questionnaires.

Results

Differences among participants in the four groups of the study were examined by running an ANOVA analysis via SPSS (Vers. 14), since ANOVA makes it possible to compare the effects of multiple levels of multiple factors. The data is presented for the research questions as below:

Which type of dictionary can lead to the most efficient dictionary use, reading comprehension and vocabulary learning?

The criteria of vocabulary search time, vocabulary reading time, frequency of dictionary consultation, and text reading time were taken as efficiency indicators of the dictionary use processes used. Search times taken in seconds for each group are shown in Table 2.

The table shows that there were significant differences between the three experimental groups of the study in vocabulary searching time, vocabulary reading time, and dictionary use frequency. Text reading time was similar for the control group and the two computer dictionary groups, but longer for the traditional dictionary group. The mean vocabulary searching time and the mean vocabulary reading times were used as indicators of how much effort students spent finding unfamiliar words in the dictionary. The ANOVA of these times as shown in Table 1 revealed significant differences across these conditions: (ANOVA **133**

Table 2. Differences between groups in post-test on vocabulary search time, vocabulary reading time, dictionary use time

Group	Vocabulary search time (seconds)		Vocabulary reading time (seconds)		Dictionary use frequency		Text reading time (seconds)	
	*Mean	SD	Mean	SD	*Mean	SD	Mean	SD
Group 1 Pop-up Dictionary	.82	0.16	4.76	1.04	29.82	6.46	658.76	81.04
Group 2-Type-in Dictionary	8.41	1.38	7.51	2.91	22.41	7.38	712.51	94.91
Group 3 Book Dictionary	22.89	8.52	12.41	4.77	15.89	6.52	821.41	101.77
Group 4 Control							683.22	122.30

$* P \geq 0.001$

results for mean search time were $F (5.44)$ and $p < .01$ and for mean vocabulary reading time were $F (5.25)$ and $p < .01.$). In pairwise comparisons, for vocabulary search time and vocabulary reading time the differences in speed between the pop-up dictionary and both of the other dictionaries was significant at the 0.01 level and the type-in dictionary was faster than the book dictionary at the same significance level. For dictionary use frequency, the difference between the pop-up dictionary and the type-in dictionary was significant at the .05 level and both of these were significantly greater than the book dictionary at the 0.01 level.

ANOVA indicated that the text reading time did not differ significantly across three of the four conditions, though the reading time for the book dictionary group was significantly longer than the other groups, $(F (5.89)$, and $p < .05$ reflecting the time taken including word searches, and despite a smaller number of dictionary searches.

In summary, the pop-up dictionary yielded the best results in terms of efficient use of time. Group 2 using the type-in dictionary had the second most efficient results. Text reading time varied between the experimental groups and the control group with the shortest time for the pop-in group and the longest for the book dictionary group.

The results above confirm the first hypothesis that among dictionary users participants using the book dictionary group will exert more effort in finding target words than those using a type-in dictionary or a pop-up dictionary, and those using a type-in dictionary will exert more effort than those using a pop-up dictionary.

Which type of dictionary would lead to the most positive evaluation by English as a foreign language readers undertaking a reading task?

To verify the second hypothesis stating that participants' attitudes towards dictionary use will vary according to the effort required in using them; questionnaire data was obtained using three questionnaire forms for the three conditions and these were tabulated and analysed using SPSS.

In scoring responses to the surveys, five points were assigned to "strongly agree" and one point to "strongly disagree". Missing responses were assigned "9" but were not included in the calculations.

Table 3 shows a comparison of the mean responses to the five questions asked about the responses about the type of dictionary they used. The most positive set of responses were for the pop-up dictionary on each item, though the difference from the type-in dictionary was marginal. However, there were greater differences for both of these over the book dictionary group.

Table 3. Mean Responses of Experimental Groups to Attitude Questions About Dictionary Use.

| | Dictionary Type | | | | | |
| | Pop-up | | Type-in | | Book | |
Question	Mean	SD	Mean	SD	Mean	SD
1. I think that the *pop-up/type-in/ book* dictionary can provide me with a rich vocabulary learning environment.	4.5256	.704	4.4132	.816	2.5937	1.192
2. I think that the *pop-up/type-in/ book* dictionary is a useful tool for quick vocabulary search.	4.5256	.691	4.3884	.915	2.7631	1.290
3. I think that the *pop-up/type-in/ book* dictionary can help me comprehend the reading text effortlessly.	4.5246	.695	4.3592	.886	3.1039	1.365
4. I think that the *pop-up/type-in/ book* dictionary is easy to use for finding the correct meanings of unfamiliar vocabulary in the reading text.	4.4968	.660	4.3585	.886	3.2324	1.223
5. I think that the *pop-up/type-in/ book* dictionary is useful for learning additional English vocabulary such as synonyms, antonyms, and homonyms related to searched for items.	4.4315	.909	4.3315	.909	3.3892	1.202

Note: Survey for each group referred only to the type of dictionary used by that group.

The most favoured type of dictionary according to this questionnaire remained the pop-up dictionary. The low standard deviations for items on the questionnaire for that group indicate that there were relatively small differences within the sample for this mode of learning.

These results gave partial support for hypothesis 2 that the attitude of participants using dictionaries will vary consistently with the amount of effort in using them. That is the most positive attitude would be for those using the pop-up dictionary followed by the type-in dictionary and then the book dictionary.

The results gave partial support for this hypothesis, however, the responses for the pop-up and type-in dictionary groups were very close and the differences between them were not significant. Consequently, this hypothesis received only partial support. However, the **135**

book dictionary participants' responses clearly indicated that this type of dictionary was the least preferred.

Which type of dictionary can result in better vocabulary learning and better reading comprehension?

Table 4 shows the mean scores of the three experimental groups and the control group on the tests of reading comprehension and vocabulary administered at the end of the project. In all cases, the experimental groups scored better than the control group with the pop-in dictionary group performing better than the other experimental groups.

Table 4. Mean Scores of Experimental and Control Groups on Reading Comprehension and Vocabulary Tests

Group	Reading Comprehension		Incidental Vocabulary Learning	
	Mean	SD	Mean	SD
Group 1 (Pop-up Dictionary)	91.42	11.46	89.62	8.47
Group 2 (Type-in Dictionary)	86.13	10.62	84.11	8.51
Group 3 (Book Dictionary)	74.10	11.38	74.13	7.58
Group 4 Control Group	62.64	8.34	52.16	6.34
P	. 01		. 01	

A Tukey *post hoc* comparison test was conducted to investigate whether the differences between these groups were significant. The results are shown in Tables 5 and 6 below.

Table 5. Tukey's Test for Pairwise Comparisons of the Groups on Reading Comprehension

Groups	Group 4 Control (62,64)	Group 3 Book (74.10)	Group 2 Type-in (86.13)	Group 1 Pop-up (91.42)
Group 4 Control (62.6)	-	11.46*	23.49*	28.78*
Group 3 Book (74.10)	-	-	12.03*	17.32*
Group 2 Type-in (86.13)	-	-	-	5.32*
Group 1 Pop-up (91.42)	-	-	-	-

$* p < 0.01$

Table 6. Tukey's Test for Pairwise Comparisons of the Groups onVocabulary Learning

Groups	Group 4 Control (52.16)	Group 3 Book (74.13)	Group 2 Type-in (84.11)	Group 1 Pop-up (89.62)
Group 4 Control (52.16)	-	21.97*	31.95*	37.46*
Group 3 Book (74.13)	-	-	9.48*	15.49*
Group 2 Type-in (84.11)	-	-	-	5.51
Group 1 Pop-up (89.62)	-	-	-	-

$* p < 0.01$

1. Each of the experimental groups had significantly higher scores than the control group on both the reading comprehension and the vocabulary tests.
2. Both group 1 (pop-up group) and group 2 (type-in group) had significantly higher scores than group 3 (book dictionary group) on both the comprehension test and the vocabulary test.
3. Group 1 (pop-up group) had higher scores than group 2 (type-in group) on both the reading comprehension test and the vocabulary test. However, these differences were not significant.

On the basis of these results, the third hypothesis was not supported. The type-in group had lower mean scores on vocabulary learning than the pop-up dictionary group even though the difference was not significant. The fourth hypothesis was partially supported in that its mean score was higher, but the difference between the pop-up group and the type-in group on this measure was also not significant. Although both the pop-up group and the type-in groups had significantly higher scores than the book dictionary group and the control group on both the comprehension test and the vocabulary test, the difference between those computer dictionary groups was not large enough to be significant.

Discussion

This study has confirmed that there was a significant main effect of using dictionaries across all three conditions and the more effective types of computer-mediated dictionaries were the pop-up dictionary, followed by the type-in dictionary. The study also showed that there was a significant main effect of using a dictionary in facilitating vocabulary learning. The tests indicated that students who used any of the three types of dictionaries scored better on the vocabulary test than students in the control group. There was one substantial difference from Liu and Lin (2011) in that this study of text reading time for the control group was similar to that for two of the dictionary users, whereas in their study it was significantly longer.

This research did not control for the content and amount of information provided by the three types of dictionary. The study also did not investigate the cognitive processes involved in reading comprehension and/or incidental vocabulary acquisition because it was not a one-session study as was the case with Liu & Lin (2011). In this study, which lasted for one semester (16 weeks), the three different types of dictionaries were used for an extended period of time. The study also sought to investigate which type of dictionary was preferred by participants who were EFL learners in the Saudi context.

The pop-up dictionary treatment yielded the best results in terms of effective use of time. The pop-up dictionary was substantially more useful to the participants than the other forms and notably yielded positive attitudes. ANOVA analyses also showed that text reading time differed for the book dictionary which was significantly longer than the other three treatments, and the pop-up dictionary group was the fastest despite substantially more dictionary checks and better comprehension than the others. It is reasonable to think that the pop-up dictionary treatment helped to reduce extraneous cognitive load, thus making available more time for the participants to concentrate on text reading and reading comprehension (Liu & Lin, 2011, Sweller, et al., 1998; Sweller, 2010; Yeung, et al., 1997). Reducing extraneous cognitive load may have helped to optimise the reading effort

of the computer dictionary groups and assist with comprehension and vocabulary learning (Acha, Peters, 2007; 2009, Yoshii, 2006).

In addition, less time taken in each dictionary look-up may have helped reduce deviation and distraction effects, also leading to better reading comprehension. This would be consistent with similar findings in prior research. (Hulstijn, et al, 1996, Pichette, 2005, Yeung, et al 1997).

Despite the availability of a dictionary during reading, readers usually do not look up all unknown words, especially when they are reading texts that are longer than a few hundred words (Hulstijn, 1993; Hulstijn, et al, 1996, Krantz, 1991). Readers need to use context to infer word meanings and use their intuition coupled with guessing abilities to counteract frequent look-ups. In addition, when proficiency level is higher, readers refer less to a dictionary, and instead rely on their intuition to reach meanings of words contextually to avoid losing time and overloading working memory capacity so they can keep focused on overall text decoding mechanisms and comprehension (Ellis, 1994; Nation & Coady, 1988).

In view of this, it is reasonable to assume that the less effort a reader exerts on look-ups, the more likely he or she will be to consult a dictionary. This would explain why the participants in this study resorted to more dictionary consultation in the easily accessible pop-up dictionary condition, but less in the more strenuous type-in dictionary and the far more strenuous searching effort in a paper-based or online dictionary. This also explains why participants in the pop-up group had more positive attitudes towards their assigned dictionary than the other three groups.

The higher level of vocabulary learning in the two computer dictionary groups indicates that these processes not only enhance reading comprehension of texts, but can also induce better incidental vocabulary learning. This is consistent with other research, such as, (Davies, 1989, Knight, 1994). The pop-up and type-in dictionaries in this study were less elaborate, time consuming and more distracting than the book dictionary, the use of which adds to extraneous cognitive load and interferes with higher cognitive processes involved in vocabulary acquisition. This finding is consistent with findings from prior research (AbuSeileek, 2011; Liu & Liu, 2011).

This finding could be considered inconsistent with some prior research, which indicated that the manipulation of the working memory for rehearsing and recalling can lead to more effective retention and retrieval of vocabulary (Baddeley, 1998; Barrouillet, Bernardin, Vergauwe, and Camos, 2007; Barrouillet & Camos, 2010; Camos & Barrouillet, 2009; Hulstijn, 2001; Fayol, Tottereau, & Barrouillet, 2006; Kim, et al., 2011, Ward, et al., 2010). This could be explained by an exposure effect (Bornstein & D'Agostino, 1994) when participants in the three dictionary treatments understand the new lexicon; whereas in the control treatment this kind of reasoning is absent.

In this case, the different forms of dictionary were used extensively over a full semester program which would have significantly enhanced their experience in dictionary use. Despite this, the effect of practice did not lead to better vocabulary acquisition without negative effects on comprehension for the type-in group as had been anticipated. It had been hypothesized that the greater familiarity and lesser cognitive load in using a type-in dictionary would have avoided a negative effect on comprehension without reducing vocabulary acquisition. However, the results may indicate a different effect, no negative effect on comprehension as a result of practice, but lesser facilitation of vocabulary because of less attention being required to seek the meaning of words.

138   Other factors that may have been of significance in this investigation include the

transfer of practice (learning) as the vocabulary test items were carefully constructed to be similar to the contexts and sentences which occurred in the original texts learned over the period of the study. In addition, dictionary consultation induces more drill and practice, and thereby, enhanced rehearsing and recalling in similar conditions. This is generally compatible with the assumption that individuals would transfer learning in one context to another that shares similar characteristics, such as performing several checks for the one word in multiple word forms, derivatives, medium of presentation, etc. (Haskell, 2001; Jiang & Kuehn, 2001; Omrod, 2004; Polson, 1988). This effect was explained by Hulstijn et al (1996) who demonstrated that the provision of marginal glosses, the use of a dictionary, and the reoccurrence of unknown words in the text can be conducive to better incremental vocabulary learning, especially when words recur and are checked several times through drill and practice.

In consideration of the results in this study, the researcher assumes a covert effect of the vocabulary searching process affecting both reading comprehension and incremental vocabulary learning due to extraneous cognitive load. In cases where this load is greater (as in the type-in e-dictionary and more in the paper-based dictionary condition), more extraneous cognitive load occurs in the working memory because of a split-attention effect produced by constant switching between searching and reading processes and between reading from computer screen and paper material. Even in the type-in online dictionary condition, this effect may have caused the interruption and dislocation of the previous reading position by the reader turning away from the text and typing in the word in the online dictionary, thus increasing the vocabulary reading time and the vocabulary searching time (AbuSeileek, 2011, Cohen, 1990; Liu & Lin, 2011, Nation, 1990). The added-cost of lost time may be an additional cognitive burden on the working memory with regard to the duration of the vocabulary reading and searching time.

It may be appropriate to conclude with the summary of Liu and Lin (2011) whose findings as a result of a one-session study were similar ...

> .. if recommendations must be made for which type of dictionary is the best to use in terms of facilitating comprehension and vocabulary learning, then the pop-up dictionary is the recommended aid." (p. 381)

The reason is probably that extraneous cognitive load is reduced with a pop-up dictionary, affording increased working memory for comprehension, and uninhibited working memory capacity for other cognitive processes including acquiring new vocabulary incidentally in the process. There are fewer distractions with a pop-up dictionary than for a type-in or book dictionary. This study has indicated that equivalently beneficial results for the pop-up dictionary were found following a full semester training program. Moreover, there did not appear to be any relatively positive effects for vocabulary acquisition detected for the type-in group as a result of their dictionary consultation.

Conclusions

For the past two decades it has been recognised that the practice of using technology for learning purposes has seen a veritable explosion (Wegner, et al., 1999). The use of technology has not only created new opportunities within the traditional classroom, but has also served to expand learning experiences beyond the popular notion of the physical classroom with its traditional learning methods and tools, leading to an interesting, attractive and **139**

interactive media of learning and teaching (Serwatka, 2003). With developments involving a much more extensive e-learning approach, the use of computer-mediated dictionaries becomes much more useful in such learning management systems. The results of this study confirmed previous results demonstrating advantages of e-dictionaries compared with book and non-dictionary conditions in both text understanding and vocabulary learning. The pop-up dictionary was found to be better due to the minimized extraneous cognitive load. This study contributes to a growing body of research (e.g., AbuSeileek, 2011 Aldosari & Mekehimer, 2010; Liu & Lin, 2011; Mekheimer, 2012) indicating that the type of dictionary can affect reading comprehension and vocabulary learning. On the other hand, more evidence needs to be gathered from further studies in different contexts to further validate the conclusions reached.

This study was affected by some limitations; for example, the amount and content of the lexical provisions in the three dictionary conditions. The potential effect of the amount of explanatory words in the pop-up condition versus the online dictionary may be investigated with regard to the cognitive load theory on reading comprehension and incidental vocabulary learning. Another future study may be devised to treat such effects in terms of differential proficiency levels and different ages of EFL learners. One more issue is the level of difficulty of glossed vocabulary items. Despite the fact that the participants in different treatment conditions studied the same glossed vocabulary items, some vocabulary items may have been easier to acquire than others by students working under different conditions, which may have skewed the results in favour of the condition to which they were assigned.

Implications of this study indicate that effort exerted in locating words in the reading text and in a particular type of dictionary may induce some sort of extraneous cognitive load. Thereby interfering with text understanding or vocabulary learning in what is known as the principle of "proximity" between glossed words and gloss. The study confirmed some prior research (e.g. AbuSeileek, 2011, Paas, et al, 2010) that the more proximate the meaning of the gloss to the glossed word, the higher achievement obtained. While this finding differs from some cognitive research advocating the favourable effects of rehearsal and training concomitant with working memory (Liu & Lin, 2011, Yeung, et al., 1997), it is consistent with other research on the effects of the dictionary type for groups which have access to e-dictionaries while reading texts.

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References

Abraham, L. B. (2008). Computer-mediated glosses in second language reading comprehension and vocabulary learning: A meta-analysis. *Computer Assisted Language Learning*, *21*(3), 199–226.

AbuSeileek, A. (2011). Hypermedia annotation presentation: The effect of location and type on the EFL learners' achievement in reading comprehension and vocabulary acquisition. *Computers & Education*, *57* (1), 1281–1291.

Acha, J. (2009). The effectiveness of multimedia programmes in children's vocabulary learning. *British Journal of Educational Technology*, *40*(1), 23–31.

Ahangari, S. & Dogolsara, S. (2015). Comparing the Effect of Using Monolingual versus Bilingual Dictionary on Iranian Intermediate EFL Learners' Vocabulary Learning. *English Language Teaching*, *8*(6), 141–149.

Al-Dararyseh, A. (2013). Activation of Using English Dictionaries by English Majors at Al-Imam University: Uses, Difficulties, and Types of Used Dictionaries. *Theory and Practice in Language Studies*, *3*(3), 423–429.

Aldosari, H. & Mekheimer, M. (2010). Utilisation of English-English Online Dictionaries for Enhancing Culture-specific Translation Skills in College Students. Paper Presented at the International Conference of Suleyman Demirel University on *"Building Cultural Bridges: Integrating Languages, Linguistics, Literature and Translation into Education"*, Almaty. April 23–24, 2010.

Anderson, J. R. (1995). *Cognitive psychology and its implications* (4th ed.). New York: Freeman.

Aust, R., Kelley, M. J., & Roby, W. B. (1993). The use of hyper-reference and conventional dictionaries. *Educational Technology Research and Development*, *41*, 63–73.

Baddeley, A. (1998). *Human memory: Theory and practice*. Needham Heights, MA: Allyn and Bacon.

Barrouillet, P., & Camos, V. (2010). Working memory and executive control: A Time-Based Resource-Sharing account. *Psychologica Belgica*, *50*, 353–382.

Barrouillet, P., Bernardin, S., Portrat, S., Vergauwe, E., & Camos, V. (2007). Time and cognitive load in working memory. Journal of Experimental Psychology: *Learning, Memory, and Cognition*, *33*, 570–585.

Béjoint, H. B., & Moulin, A. (1987). The place of the dictionary in an EFL programme. In A. Cowie (Ed.), *The dictionary and the language learner* (pp.381-392). Tübingen: Niemeyer.

Bogaards, P. (1994). *Le vocabulaired ans l'apprentissagdees langues etrangeres*. Saint-Jean de Bray, France: Hatier/Didier.

Bogaards, P., Laufer, B., & Varantola, K. (1996). *AILA symposium on dictionary use*. AILA 1996 World Congress, Jyvaskyla.

Bornstein, R. F., & D'Agostino, P. R. (1994). The attribution and discounting of perceptual fluency: Preliminary tests of a perceptual fluency/attributional model of the mere exposure effect. *Social Cognition*, 12, 103–128.

Bruton, A. (2005). Process writing and communicative-task-based instruction: Many common features, but more common limitations? *TESL-EJ 9*(3): 1–28.

Bruton, A. (2007). Vocabulary learning from dictionary reference in collaborative EFL translational writing. *System*, 35, 353–367.

Camos, V., Lagner, P. & Barrouillet, P. (2009). Two maintenance mechanisms of verbal information in working memory. *Journal of Memory and Language*, 61, 457–469.

Chapelle, C., & Jamieson, J. (2008). Tips for teaching with CALL: Practical approaches to computer-assisted language learning [with CD]. White Plains, NY: Pearson-Longman.

Christianson, K. (1997). Dictionary use by EFL writers: what really happens? *Journal of Second Language Writing*, *6*(1), 23–43.

Chun, D. (2001). L2 Reading on the web: strategies for accessing information in hypermedia. *Computer Assisted Language Learning*, *14*(5), 367–403.

Coady, J. (1997). L2 acquisition through extensive reading. In J. Coady and T. Huckin, (eds.). *Secondary language vocabulary acquisition*. (225–237). New York: Cambridge University Press.

Craik, F., & Lockhart, R. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behaviour*, 11(6), 671–684.

Davies, N. (1989). Facilitating effects of marginal glosses on foreign language reading. *Modern Language Journal*, 73, 41–48.

Dwaik, R. (2015). English Digital Dictionaries as Valuable Blended Learning Tools for Palestinian College Students. *English Language Teaching*, *8*(11), 1–10.

Ellis, R. (1994). Factors in the incidental acquisition of second language vocabulary from oral input: A review essay. *Applied Language Learning*, 5, 1–32.

El-Sayed, A. & Siddiek, A. (2013). Review of EFL Learners' Habits in the Use of Pedagogical Dictionaries. *English Language Teaching 6*(8), 54–65.

Erçetin, G. (2010). Effects of topic interest and prior knowledge on text recall and annotation use in reading a hypermedia text in the L2. *ReCALL*, 22, 228–246.

Fageeh, A. & Mekheimer, M. (2011). EFL learners' vocabulary acquisition in translational writing. *Journal of Language Teaching and Research*. Manuscript accepted for publication February, 13th 2011.

Fayol, M., Tottereau, C., & Barrouillet, P. (2006). Disentangling the impact of semantic and formal factors in the acquisition of number inflection: Noun, adjective, and verb agreement in written French. *Reading and Writing*, *19*, 717–736.

Hartmann, R. R. K. (1989). What we (don't) know about the English language learner as a dictionary user: a critical select bibliography. In Tickoo, M. L. (Ed.), *Learners' Dictionaries: State of the Art*. Anthology Series 23 (pp. 213–221). Singapore: Southeast Asian Ministers of Education Organization, Regional Language Centre.

Haskell, R. E. (2001). Transfer of Learning. Cognition, Instruction, and Reasoning. San Diego: Academic Press.

Hulstijn, J. H. (2001). Intentional and incidental second language vocabulary learning: A reappraisal of elaboration, rehearsal and automaticity. In P. Robinson (Ed.), *Cognition and second language instruction* (pp. 258–286). Cambridge University Press.

Hulstijn, J. H., Hollander, M., & Greidanus, T. (1996). Incidental vocabulary learning by advanced foreign language students: The influence of marginal glosses, dictionary use, and reoccurrence of unknown words. *The Modern Language Journal*, *80*(3), 327–339.

Jiang, B., & Kuehn, P. (2001). Transfer in the Academic Language Development of Post-secondary ESL Students. *Bilingual Research Journal*, 25, 417–436.

Jin, L. & Deifell, E. (2013). Foreign Language Learners' Use and Perception of Online Dictionaries: A Survey Study. *Journal of Online Learning and Teaching*, *9*(4), n/a.

Kilickaya, F. (2010). Comparative usefulness of online and traditional vocabulary learning. *The Turkish Online Journal of Educational Technology*, *9*(2).

Kim, K., Byun, E., Lee, S., Gaillard, W., Xu, & Theodore, W. (2011). Verbal working memory of Korean-English bilinguals: An fMRI study. *Journal of Neurolinguistics*, *24* (1), 1–13.

Knight, S. (1994). Dictionary use while reading – the effect on comprehension and vocabulary acquisition for students of differential verbal-abilities. *Modern Language Journal*, *78*(3), 285–299.

Krashen, S. (1982). Principles and practice in second language acquisition. New York: Pergamon Publishers.

Krashen, S. (1989). We acquire vocabulary and spelling by reading: Additional evidence for input hypothesis. *Modern Language Journal*, 73, 440–463.

Kubota, M. (2001). Error correction strategies used by learners of Japanese when revising a writing task. *System*, *29*(1), 467–80.

Laufer, B. (2000). Electronic dictionaries and incidental vocabulary acquisition: does technology make a difference? Proceedings of Euralex 2000.

Laufer, B. (1997). The lexical plight in second language reading: words you don't know, words you think you know and words you can't guess. In J. Coady and T. Huckin (eds.). *Second Language Vocabulary Acquisition: a Rationale for Pedagogy* (pp. 20–34), Cambridge University Press.

Laufer, B., & Hulstijn, J. (2001). Incidental vocabulary acquisition in a second language: The construct of task-induced involvement. *Applied Linguistics*, *22*(1), 1–26.

Leffa, V.J. (1992). Reading with an electronic glossary. *Computers and Education*, 19(3), 285–290.

Liu, T. & Lin, P. (2011). What comes with technological convenience? Exploring the behaviours and performances of learning with computer-mediated dictionaries. *Computers in Human Behaviour, 27* (1) 373–383.

Luppesku, S., & Day, R. (1993). Reading, dictionaries, and vocabulary learning. *Language Learning, 43*, 263–287.

Marsden, A., Mackenzie, A., & Lindsay, A. (2007). Tools for searching, annotation and analysis of speech, music, film and video data survey. *Literary and Linguistic Computing*, *22* (4), 469–488.

Mekheimer, M. (2012). Assessing aptitude and attitude development upon teaching translation skills using LMS and an online dictionary. *CALICO Journal*, *29* (2), 321–340.

Mondria, J. (1993). The effects of different types of context and different types of learning activity on the retention of foreign language words. *Paper presented at the 10th AILA World Congress of Applied Linguistics, Amsterdam*.

Nation, I.S.P., & Coady, J. (1988). Vocabulary and reading. In R. Carter & M. McCarthy (Eds.), *Vocabulary and language teaching* (pp. 97–110). London: Longman.

Nation, Paul & Carter, Ron (ed.) (1989). Vocabulary Acquisition, special issue of *AILA* [Association Internationale de Linguistique Appliquée] *Review*, 6.

O'Keeffe, Anne, Michael McCarthy, and Ronald Carter. (2007). *From corpus to classroom: language use and language teaching*. Cambridge: Cambridge University Press.

Ormrod, J.E. (2004). *Human learning* (4th ed.). Upper Saddle River, NJ: Pearson.

Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science*, 32, 1–8.

Paas, F., van Gog, T., & Sweller, J. (2010). Cognitive load theory: New conceptualizations, specifications, and integrated research perspectives. *Educational Psychology Review*, *22*, 115–121.

Paas, F.G.W.C., and Van Merriënboer, J.J.G. (1993). The efficiency of instructional conditions: An approach to combine mental-effort and performance measures. *Human Factors*, *35* (4): 737–743.

Peters, E. (2007). Manipulating L2 learners' online dictionary use and its effect on L2 word retention. *Language Learning and Technology*, *11*(2), 36–58.

Pichette, F. (2005). Time Spent on Reading and Reading Comprehension in Second Language Learning. *The Canadian Modern Language Review*, 62 (2), 243–262.

Piotrowski, T. (1989). Monolingual and bilingual dictionaries: fundamental differences. In M. Tickoo (Ed.), *Learners' dictionaries: State of the art* (pp. 72–83). Singapore: SEAMEO Regional Language Centre.

Plass, J. L., Chun, D. M., Mayer, R. E., & Leutner, D. (2003). Cognitive load in reading a foreign language text with multimedia aids and the influence of verbal and spatial abilities. *Computers in Human Behaviour*, 19, 221–243.

Polson, P. G. (1988). Transfer and retention. In R. Guindon (Ed.), *Cognitive Science and its Application for Human-Computer Interaction* (pp. 59–162). Hillsdale, NJ: Lawrence Erlbaum Associates.

Rott, Hans (2000). Words in Contexts: Fregean Elucidations. *Linguistics and Philosophy*, 23, 621–641.

Rott, S. (1999). The effect of exposure frequency on intermediate language learners incidental vocabulary acquisition and retention through reading. *Studies in Second Language Acquisition*, *21*, 589–619.

Serwatka, J. A. (2003). Internet-based Instruction in CIS Courses. Internet paper available at http://www.ihets.org/index.html

Sharma, P. (2008). CALL dimensions: options and issues in computer-assisted language learning: a practical guide to using computers in language teaching. *ELT Journal*, *62*(1), 102–105.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review*, *22*, 123–138.

Uzawa, K. (1996). Second language learners' process of L1 writing, L2 writing, and translation from L1 to L2. *Journal of Second Language Writing 5*, 271–294.

Ward G., Tan, L., & Grenfell-Essam, R. (2010). Examining the relationship between free recall and immediate serial recall: the effects of list length and output order. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *36*, 1207–1241.

Wegner, S. B., Holloway, K. C., & Garton, E. M. (1999). The effects of Internet-based instruction on student learning. *Journal of Asynchronous Learning Networks*, *3*, 98–106.

Yeung, A. S., Jin, P., & Sweller, J. (1997). Cognitive load and learner expertise: Splitattention and redundancy effects in reading with explanatory notes. *Contemporary Educational Psychology*, *23*, 1–21.

Yoshii, M. (2006). L1 and L2 glosses: their effects on incidental vocabulary learning. *Language Learning and Technology*, *10*(3), 85–101.

Zhiliang, S. (2008). A comparative study of three learning strategies in EFL students' incidental vocabulary acquisition. *CELEA Journal*, *31* (6),91–101.

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Appendix A

The vocabulary test

Instructions: The problems in this section are of different types, as illustrated by the examples below:

Example I:	**Example II:**
feverish	related to work
A. evil	A. occupational
B. hot	B. recreational
C. hungry	C. rotational
D. poor	D. sensational

In **Example I** you find a test word, beneath which are four words marked A, B, C or D. You should choose the one word of the four whose meaning is nearest to the meaning of the test word. In this example the word nearest to the meaning of the word "feverish" is the word "hot". If this were a part of the test, you would blacken the circle for the letter B on your answer sheet.

    Example II gives you a test definition which defines one of the four words below it. The definition "related to work" tells you the meaning of the word "occupational," which is choice A. Your answer sheet would be marked with a blackened circle for the letter A.

    Please remember to make marks *only on the answer sheet,* NOT on the test booklet. If you understand the directions continue the test and answer all of the items numbered 26 through 50. If you have any questions, raise your hand and one of the teachers will be happy to help you.

....

    Please turn the page and work on the vocabulary test.

....

1. environment
   A. character
   B. condition
   C. position
   D. surroundings

2. methodical
   A. being economical
   B. happening frequently
   C. well-behaved
   D. well-organized

3. undergo change
   A. contrast
   B. disagree
   C. modify
   D. vary

4. culture
   A. advance in values
   B. learning experience
   C. shared beliefs and values
   D. uncontrollable conditions

5. positively
   A. absolutely
   B. actually
   C. emphatically
   D. sincerely

6. give ownership of
   A. distribute
   B. move
   C. replace
   D. transfer

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7. voluminous
   A. generous
   B. liberal
   C. loose
   D. sufficient

8. business associate
   A. equal
   B. fellow
   C. partner
   D. superior

9. dominate
   A. carry out
   B. fail to notice
   C. have power over
   D. let pass

10. appearing for the first time
    A. active
    B. emergent
    C. evolving
    D. rising

11. overall
    A. by and large
    B. in the usual way
    C. on a regular basis
    D. on many occasions

12. undertake
    A. employ
    B. endure
    C. perform
    D. suppose

13. equivalent
    A. complement
    B. counterpart
    C. opponent
    D. similarity

14. objectively
    A. with criticism
    B. with a purpose
    C. without giving a reason
    D. without personal influence

15. whereas
    A. for the reason that
    B. at the same place
    C. while in contrast
    D. in addition to

16. all of a person's possessions
    A. loan
    B. fund
    C. estate
    D. principal

17. a speech
    A. a lecture
    B. a letter
    C. an election
    D. an element

18. utilize
    A. to speak
    B. to wait for
    C. to make use of
    D. to understand as

19. eliminate
    A. return
    B. relapse
    C. retain
    D. remove

20. point of view
    A. summary
    B. paradigm
    C. instance
    D. examination

21. voluntarily
    A. with effort
    B. with speed
    C. by force
    D. by choice

22. not directly stated
    A. implicit
    B. explicit
    C. imposed
    D. exposed

23. widespread
    A. long
    B. heavy
    C. educated
    D. common

24. manually
    A. by hand
    B. on foot
    C. with ease
    D. for fun

25. the ability to see
    A. vigor
    B. vision
    C. variance
    D. vitality

Answer key:

1. D	10. B	19. D
2. D	11. A	20. B
3. D	12. C	21. D
4. C	13. B	22. A
5. A	14. D	23. D
6. D	15. C	24. A
7. C	16. C	25. B
8. C	17. A	
9. C	18. C	

Appendix B

Opinion Survey

Your opinion about using a dictionary
Please place a tick (✓) in the column beside each statement to indicate your agreement or disagreement according to the scale to the right

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I think that the *pop-up/type-in/book* dictionary can provide me with a rich vocabulary-learning environment.					
2. I think that the *pop-up/type-in/book* dictionary is a useful tool for quick vocabulary search.					
3. I think that the *pop-up/type-in/book* dictionary can help me comprehend the reading text effortlessly.					
4. I think that the *pop-up/type-in/book* dictionary is easy to use for finding the correct meanings of unfamiliar vocabulary in the reading text.					
5. I think that the *pop-up/type-in/book* dictionary is useful for learning additional English vocabulary such as synonyms, antonyms, and homonyms related to searched for items					

Appendix C

Reading comprehension test passages

Alexander Fleming: Discoverer of "miracle drug" penicillin
   by Ian Lundy

In his cluttered research laboratory, bacteriologist Alexander Fleming made an accidental discovery that would forever change the world of modern medicine.

   He was clearing his sink of a pile of petri dishes, in which he had been growing bacteria, and was checking each one before discarding it. Then the contents of one dish caught his eye. Common fungal mould, like that found on stale bread had grown and appeared to be killing off the harmful bacteria inside. Next, Fleming conducted a series of tests on the fungus, *penicillium notatum* and successfully isolated the antibiotic substance which he called penicillin.

   "One sometimes finds what one is not looking for" remarked Fleming in typically understated fashion.

   What the Scottish scientist had found in September 1928 proved to be the greatest breakthrough in the treatment of infection the world had witnessed. At first it was underestimated by the medical community. Later, Fleming's work was taken on in the 1930s by chemists Howard Florey and Ernst Chain. They purified penicillin to a more useful treatment form. With their work, the scale of Fleming's discovery became obvious.

   British and American drug companies mass-produced penicillin. The new drug was hailed as a medical miracle during World War II when it saved millions of lives by crippling the biggest wartime killer – medical wounds.

   During World War I, Fleming served as a captain in the Royal Army Medical Corps, working in the laboratory of a battlefield hospital in France. His exposure to the terrible battlefield wounds that claimed the lives of thousands of soldiers strengthened his determination to develop a powerful and useful antiseptic.

   In the 1920s, again by accident, he had discovered lysozyme, now known in medical circles as "the little brother of penicillin". An enzyme occurring in bodily fluids, for example, in tears, lysozyme has a natural antibiotic effect. First, Fleming had sneezed into a bacteria-laced petri dish. Several days later, he noticed that the bacteria had been destroyed by the mucus. But lysozyme was not effective against the stronger infectious agents and Fleming kept searching until his monumental discovery several years later.

   "Nature makes penicillin, I just found it" he said at the time. Penicillin is today used commonly along with many other antibiotics, for example amoxicillin or tetracycline, to treat all kinds of bacteria, prevent infection, and save lives.

Echinacea: It works; oops, it works not
   by Elizabeth Weise

The National Institute of Health (NIH) has bad news for millions of Americans. They spend $155 million a year on the popular herbal remedy Echinacea to treat the cough and runny nose of their common colds. But Echinacea, a new study shows, doesn't work.

148   It's not clinically effective, says Ronald Turner. Turner should know. He is an expert on

the common cold at the University of Virginia School of Medicine. He wrote the ethinacea study. His study, reported in the current New England Journal of Medicine, is the best test ever done on the effectiveness of the herbal remedy, says Stephen Straus. Straus directs the NIH's National Centre for Complementary and Alternative Medicine.

Turner's is the third study in three years that showed that echinacea was not effective in lessening cold symptoms in children or young adults. The findings of these three studies are the opposite of positive reports on echinacea's effects, mostly from studies done in Europe.

In Turner's study, researchers at the University of Virginia randomly gave 399 volunteers either Echinacea extract or a placebo for seven days. They then put drops containing cold germs in their noses to give them colds. Finally, the researchers left them alone in hotel rooms so that they couldn't get a cold from anyone or anything else.

The goal was to find out if taking ethinacea prevents infection or can limit the length of a cold. "The answer was no", Turner says. "It has no effect on the rate at which volunteers get infected or on their symptoms." More than 80% of volunteers in both groups got a cold.

The problem with colds, which last about seven days, is "no matter what you do, you're going to get better," Straus says. That might make people think that taking Echinacea helps when it doesn't.