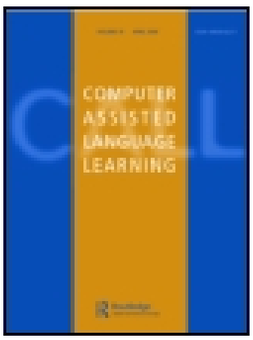

Computer Assisted Language Learning

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ncal20

Investigating the effectiveness of a digital game-based task on the acquisition of word knowledge

Amin Rasti-Behbahani & Maryam Shahbazi

To cite this article: Amin Rasti-Behbahani & Maryam Shahbazi (2020): Investigating the effectiveness of a digital game-based task on the acquisition of word knowledge, Computer Assisted Language Learning, DOI: 10.1080/09588221.2020.1846567

To link to this article: https://doi.org/10.1080/09588221.2020.1846567

Published online: 01 Dec 2020.

COMPUTER ASSISTED LANGUAGE LEARNING
https://doi.org/10.1080/09588221.2020.1846567

Routledge
Taylor & Francis Group

Investigating the effectiveness of a digital game-based task on the acquisition of word knowledge

Amin Rasti-Behbahani[a] and Maryam Shahbazi[b]

[a]Department of Languages and Communication Studies, University of Jyvaskyla, Jyvaskyla, Finland; [b]Department of Teacher Education, Jyväskylä University of Applied Sciences, Jyvaskyla, Finland

ABSTRACT

This study investigates the probable effect of a digital game-based vocabulary learning (DGBVL) task on the acquisition of some components of a word knowledge framework. In so doing, 124 Persian speakers (56 males and 68 females) were randomly assigned to either a control or an experimental group. The experimental group participants completed a DGBVL task for acquiring ten low-frequent inanimate object names, or lexical nouns, by playing a commercial adventure game. The control group participants practiced the same words in a fill-in-the-blank vocabulary acquisition exercise. In brief, first, all participants sat for a word-checklist and a proficiency test; next, they completed their tasks, and three weeks later, all participants sat for eight achievement tests. In the achievement test booklet, participants' knowledge of receptive, productive, recognition, and recall dimensions and scopes of meaning, orthography, and association were evaluated. The results revealed 1) the efficiency of the DGBVL task in enhancing the acquisition of these components, 2) the precedence of productive knowledge acquisition by the experimental group participants, 3) strong associations among the components acquired through DGBVL task assistance, and 4) gains in the components that were not associated with others due to the efficiency of DGBVL.

KEYWORDS

Digital game-based learning; vocabulary acquisition; word knowledge framework

1. Introduction

Acquiring vocabulary is essential for language learners because "all other things being equal, learners with big vocabularies are more proficient in a wide range of language skills than learners with smaller vocabularies"

CONTACT Amin Rasti-Behbahani amin.rasti@outlook.com Department of Languages and Communication Studies, University of Jyvaskyla, Jyvaskyla, Finland.

(Krashen, 1989, p. 440). However, the multidimensionality of knowing a word has made vocabulary acquisition challenging. In other words, a language learner needs to retain information such as receptive, productive, form, meaning, and use for every word. These bits of information have been grouped into categories named aspects, dimensions, and scopes (Nation, 2001; Ringbom, 1987). For acquiring aspects, dimensions, and scopes of word knowledge effectively, many methods and techniques are proposed, studied, and recommended; however, since no particular method has yet shown to be very effective the search for a comprehensive method of vocabulary acquisition continues.

Recently, researchers have found digital games as "another avenue for experimentation in a safe virtual environment" (Kirriemuir, 2002, p. 2). However, there are mixed reports on the effect of DGBVL tasks. For example, although some studies report about the potentials of DGBVL tasks (Chen, Tseng, & Hsiao, 2018; Zou, Huang, & Xie, 2019), the inefficacy of DGBVL tasks was reported and discussed in a few other studies (e.g., deHaan, Reed, & Kuwada, 2010; Lee, 2019). These studies have mainly reported on the effect of digital games on the acquisition of receptive knowledge of form-meaning (Zou et al., 2019), and mostly disregarded the multidimensionality of knowing a word despite the existence of strong reasons for considering it. For instance, firstly, aspects, dimensions, and scopes are interrelated knowledge bases (Schmitt & Meara, 1997) and may affect each other. Secondly, although language learners may obtain some aspects, dimensions, and scopes of word knowledge, they cannot demonstrate knowledge of meaning (Schmitt, 1998). Thirdly, "using only a receptive or productive test to measure [vocabulary] learning might provide misleading results" (Webb, 2005, p. 50). Hence, we can infer that disregarding the multidimensionality of knowing a word and measuring only receptive/productive knowledge of meaning might have led to the mixed results in the DGBVL literature. In order to fill this gap, this study reinvestigates the effect of a digital game task on vocabulary acquisition by considering the multidimensionality of word knowledge. By doing so, we can obtain more precise information on the effect of a DGBVL task. Also, it may reveal what kind of word knowledge is acquired before others (Schmitt, 1998).

2. Literature review

2.1. Components of word knowledge

Aspects, dimensions, and scopes of word knowledge are outcomes of the researchers' attempts to answer *what does it mean to know a word?* For instance, Richards (1976) answered that knowing a word was the acquisition of pieces of knowledge such as frequency, degree of exposure,

Table 1. Aspects Involved in Knowing a Word (adapted from Nation, 2001, p. 27).

Form	Spoken	R	What does the word sound link?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written and spelled?
	Word parts	R	What parts are recognizable in this word?
		P	What word parts are needed to express the meanings?
Meaning	Form and meaning	R	What meaning does this word form signals?
		P	What word form can be used to express this meaning?
	Concept and referents	R	What is included in this concept?
		P	What items can the concept refer to?
	Associations	R	What other words does this make us think of?
		P	What other words could we use instead of this one?
Use	Grammatical functions	R	In what patterns does the word occur?
		P	In what pattern must we use this word?
	Collocations	R	What words or type of words with this one?
		P	What words or type of words must we use with this?
	Constrains on use (register, frequency, ect.)	R	Where, when, and how often would we expect to meet this word
		P	Where, when, and how often can we use this word?

R = Receptive Knowledge P = Productive Knowledge.

Table 2. Degrees of form-meaning knowledge (adapted from Laufer & Goldstein, 2004, p. 407).

	Recall	Recognition
Productive (retrieval of form)	Supply the L2 word	Select the L2 word
Receptive (retrieval of meaning)	Supply the L1 word	Select the L1 word

association, functions, syntax, derivations, semantic, and synonyms. Ringbom (1987) explained that to know a word, a language learner would need to retain its form (morphology), meaning (semantics), use (syntax), relevant words (association), accessibility, and collocation. Finally, Nation (2001) summarized the previous answers and introduced the word knowledge framework (Table 1). In this framework, knowing a word means acquiring aspects such as form, meaning, and use and the receptive and productive dimensions. Receptive knowledge is the ability to recognize and understand a word in a written or spoken form, and productive knowledge is the ability to use a word in writing or speaking (Nation, 2001).

Also, the receptive/productive dimension has been considered to encompass two scopes, namely, recognition and recall, and mainly in the form-meaning aspect of word knowledge, as defined in Table 2 (Laufer & Goldstein, 2004).

2.2. Acquiring components of the word knowledge framework

In the literature of vocabulary acquisition, the precedence of receptive knowledge has been widely discussed, especially in acquiring form-meaning knowledge (Meara, 1997; Mondria & Wiersma, 2004; Schmitt, 2010; Webb, 2005). Nevertheless, Webb (2005) found that higher gains in receptive

knowledge were conditional on some contributory factors. He investigated whether learning nonsense words, both receptively and productively, could enhance gains in aspects of the word knowledge framework. Two groups of Japanese participants tried to learn 14 nonsense words by practicing them on a three glossed sentences task and a sentence writing task. Then, their knowledge of orthography, syntax, association, form, and meaning were evaluated by a 10-page test booklet. The results showed that the participants performed significantly better in productive knowledge tests. Webb (2005) discussed how factors like the type of task, ceiling effects on the receptive test, and the experiment's design could have supported the acquisition of productive knowledge. Eventually he concluded that productive vocabulary learning tasks could enhance the acquisition of components of the word knowledge framework significantly. These findings by Webb (2005) matter because they show that the acquisition of components of the word knowledge framework is controllable, and the route and rate of acquisition can be altered by vocabulary learning tasks.

Regarding the effect of task types, De La Fuente (2002) investigated the effect of tasks such as "non-negotiated premodified input (NNPI), negotiation without pushed output (NIWO), and negotiation plus pushed output (NIPO)" (p. 84) on the acquisition of receptive and productive knowledge of 10 Spanish target words. She showed how although negotiation had been found to have a positive effect on vocabulary acquisition, some types of negotiation would not enhance vocabulary acquisition and retention at a similar rate. After participants had completed their tasks, she evaluated their receptive and productive knowledge of the target words immediately and then again three weeks later. She found that although the participants had significantly increased both receptive and productive knowledge of the target words, they performed better in productive knowledge tests. She concluded that the type of task plays a significant role in the acquisition of the aspects of the word knowledge framework. Moreover, Webb (2007) studied the effect of contextualized and decontextualized vocabulary learning tasks. He recruited 84 Japanese EFL students and assigned them to either experimental (A), or comparison (B) groups. Group A experienced target words in glossed sentences, whereas group B learned them in word pairs. Different types of word knowledge, such as orthography, pragmatic association, meaning and form, syntagmatic association, and grammatical function, were measured separately immediately after the task completion. Results showed no significant difference between the two groups. However, he found that participants' gains in the productive knowledge of meaning and the receptive knowledge of orthography were noticeable. Webb (2007) concluded that explicit vocabulary learning tasks, designed to strengthen the

form-meaning link, should be encouraged because generating and developing a strong form-meaning link might enhance the acquisition of syntagmatic and paradigmatic association and grammar. Webb's finding supported the previous findings by Schmitt (1998) and Schmitt and Meara (1997). They found that some aspects and dimensions of word knowledge, primarily meaning, suffix knowledge, and word association knowledge, were associated with each other.

2.3. Digital games and the acquisition of components of the word knowledge framework

The literature on DGBV has grown significantly over the past decade. Many of those studies report on the positive effect of digital games on vocabulary acquisition. For example, Vahdat and Rasti-Behbahani (2013) reported that both female and male Iranian EFL learners who played a commercial adventure digital game acquired receptive form-meaning knowledge of 45 target words more effectively than those who tried to acquire the same target words through text-and-drill exercises. Rabu and Talib (2017) found that learners of English who played an educational/serious game showed a significantly better performance than control group participants who learned through drills in the post-tests evaluating productive form-meaning knowledge of target words. Ebrahimzadeh and Alavi (2017) reported that commercial digital games can support vocabulary acquisition and enhance the retention of receptive knowledge of form-meaning recognition. Chen and Hsu (2019) found that digital games are not only effective in acquiring the receptive form-meaning knowledge of vocabulary items but also in content acquisition. Bahari (2020) reported that digital games, in general, can increase both the depth and size of the gamers' English word knowledge. Generally speaking, regarding the recent meta-analysis studies, digital games have the potentials to enhance vocabulary acquisition (Chen et al., 2018; Zou et al., 2019).

However, the focus of the available DGBVL literature is mainly on the acquisition of receptive (recognition or recall) word knowledge while the acquisition of productive word knowledge is neglected or rarely studied (Zou et al., 2019). In other words, few studies considered multidimensionality, or at least both receptive and productive knowledge, of vocabulary acquisition. For instance, Jasso (2012) investigated the effect of playing *SIMS* on the acquisition of both receptive and productive knowledge of clothes-related vocabulary items. She found that the experimental group participants outperformed the control group participants in both tests. Moreover, she reported that the experimental group

participants showed a significantly better performance in the productive test than in the receptive test. Sundqvist and Wikström (2015) compared the receptive and productive vocabulary knowledge of 80 Swedish teenage gamers. They categorized them into non/low-gamers, moderate gamers, and frequent gamers. They reported that the performance of frequent gamers was noticeably better in both receptive and productive tests. Janebi Enayat and Haghighatpasand (2019) compared the performance of participants who played *The Secret of Monkey Island - Special Edition* in learning target words, to the performance of participants who learned the same target words through classroom vocabulary learning tasks only, in a receptive and productive recall post-tests. They found that experimental group participants outperformed control group participants in both post-tests. They concluded that factors such as the richness of input, interactive dialogues, the contextualized exposure to unknown words, and the frequency of occurrence in digital games could enhance vocabulary acquisition efficiently. Last but not least, Sundqvist (2019) compared digital game players (B: N = 16) with non-players (A: N = 1,069) in their receptive and productive vocabulary knowledge through 3 years of study. Playtime correlated positively with receptive as well as productive test scores. Furthermore, she found that gamers acquired productive knowledge of both frequent and infrequent vocabulary items effectively. She concluded that commercial games could be useful for vocabulary acquisition.

There remains a gap in our knowledge of the effect of digital games on the acquisition of components of the word knowledge framework. Hence, to fill this gap and to achieve the main aim of this study, we seek answers to the following questions:

1. Does a DGBVL task make a significant difference in the acquisition of aspects, dimensions, and scopes of the word knowledge framework in comparison with a regular vocabulary learning task?
2. Which aspects, dimensions, and scopes of the word knowledge framework are acquired significantly more efficiently?
3. To what extent are learned word knowledge framework components correlated to one another?

3. Methodology

The design of the study was modeled on the study by Webb (2007). The independent factor was a DGBVL task, and the dependent factor was the acquisition of some components of the word knowledge framework.

3.1. Participants

In this study, based on a convenience sampling method, we recruited 124 Persian speakers from two private English language learning institutes in Behbahan, Iran. The Oxford placement test (2004) revealed that the volunteers' English proficiency was at the lower-intermediate level. The participants, both male (N = 56) and female (N = 68) teenagers (11 − 13 years old), were randomly assigned to either control (N = 62) or experimental groups (N = 62). Moreover, both participants and their families were asked to fill in a consent form after being acquainted with their rights and the ethics of the research.

3.2. Materials

We used a digital game, a game-guide, or walkthrough, and a regular vocabulary learning task (RVLT). They are explained in detail below.

3.2.1. The digital game

The digital game, *Haunted Hotel: Death Sentence – Collectors' Edition*, was developed by *Big Fish* Games. It is a commercial adventure point-and-click PC game, in which a gamer takes the role of a detective who tries to solve the mystery of his friend's murder in an abandoned hotel. The gamer can control the game by mouse clicks. We came to the conclusion that among all other genres of digital games, the adventure genre would be a pedagogically suitable choice for our study because

> adventure games use intrinsic motivation. Intrinsically motivating games incorporate learning activity in a virtual world. Game characters have to solve a certain problem and can proceed further only after solving the problem. In this case, the problem is part of the game and players are motivated to provide a solution in order to continue with the game. (Pivec, Dziabenko, & Schinnerl, 2003, p. 218)

The game contains a series of events that must be solved by finding specific objects. If gamers cannot solve the first problem, the second problem does not appear, that is to say, the game does not progress. Gamers can find the required objects in one of the following ways: by searching the game areas, by combining collected objects, or by solving issues in previous events. Likewise, the objects must be either used in a specific area or place in the game or combined with other objects to create another useful object. For instance, the following figures show two examples of how objects can be used in the game (Figures 1 and 2).

Figure 1. A gamer is trying to use an object (a rock) to interact with the environment (breaking the glass).

Figure 2. A gamer is trying to combine and fix the found pieces of an object (a door knob) to solve a problem (opening a door) in the game.

3.2.2. Walkthrough

A walkthrough is an instruction manual for the game. It helps a gamer to complete the game by following its instructions. The walkthrough was downloaded from the official website of the game. The first chapter of the walkthrough was extracted and simplified by numbering the sentences, putting them in numerical order, adding picture guides for the mini-games that were not relevant to study but had to be played, and rewriting complex sentences to make it both user-friendly and easy to follow (Table 3).

Participants were given the walkthrough to prevent the negative effects of extensive interactivity, which can result in negative cognitive load and probably lead to difficulty in recalling vocabulary items (deHaan et al., 2010). Moreover, it could reduce time-on-task and prevent demotivation.

Table 3. An excerpt from the walkthrough.

5. use the stone and click on the window 2 times; click on the latch; click on the door to open
6. now, try to find things in the list
7. click on the hook

Table 4. The target words profile.

Target words	Number of frequencies in the text	Frequency profile
Debris	1	K5
Drape	1	K5
Embers	1	K9
Tag	1	K4
Glove	1	K4
Latch	1	K6
Skeleton	1	K5
Projector	1	K8
Shack	1	K7
Skull	1	K4

3.2.3. RVLT

The RVLT was a fill-in-the-blanks task that was designed by the researchers. In this task, the control group participants had to complete ten sentences by choosing appropriate words from the wordlist at the top of the page (Appendix A). The wordlist contained 12 words, and the sentences were extracted from the British National Corpus. The control group participants did not need to modify the grammatical form of the words to fit their sentences.

3.2.4. Target words

Firstly, we selected forty nouns, which were not repeated more than twice throughout the first chapter of the walkthrough. The selected nouns were names of inanimate objects. The experimental group participants needed to know them to be able to solve the puzzles in the game. A vocabulary checklist containing the selected forty nouns ensured that all the selected words were entirely new for the participants in both groups. After we had administered the checklist, we discovered that only twelve nouns were new for the participants in both groups. We chose ten out of the twelve nouns because those ten words were repeated only once throughout the first chapter (Table 4). In so doing, we partially controlled the unintended effects of the exposure frequency. The target words are in the classes (K) of low-frequent words based on their frequency profile[1]. Finally, we selected only nouns because it was found that, among other lexical classes, nouns are acquired more effectively by DGBVL tasks (Rasti-Behbahani, 2017).

3.3. Instruments

We used the Oxford placement test (2004), a vocabulary checklist, and a test booklet for eliciting data from the participants in this study. The

Oxford placement test was administered to identify the participants' level of English language proficiency. The test contained 60 items that measured the participants' knowledge of vocabulary, grammar, and their reading comprehension. Based on the report by Geranpayeh (2003), this version of the test has high validity and reliability (0.90).

Also, a vocabulary checklist was administered to test whether the participants knew the selected target words. It contained forty nouns - names of inanimate objects - that were selected from the first chapter of the walkthrough. In the checklist all 124 participants were supposed to checkmark *yes* if they knew the target words and to write whatever they knew about it. They could have written, for example, Persian definitions, synonyms, antonyms, relevant words, etc.

Moreover, based on the study by Webb (2007), we designed and sequenced eight achievement tests carefully to measure the participants' knowledge of aspects, dimensions, and scopes of the target words. Assuming that randomly administering the tests would reduce the effects of earlier tests affecting the result of later tests, we sequenced the tests in the following order: *A, F, B, H, E, D, G, C* (tests are listed and described below). Also, we randomly distributed the target words in each test to control the learning from the tests even more effectively. By doing so, we assumed that, for instance, what learners may learn from test *A* would be of little or no use in test *F* and so on. Furthermore, we had to isolate each component of the word knowledge framework to provide a more accurate assessment of the relative efficacy of the tasks (Webb, 2007).

We also did not provide context for cues in the achievement tests to avoid the effect of context on guessing the answers and to reduce the similarity between the achievement tests and the tasks (Webb, 2007). For example, in test C, question 1 contained just the word *Skull* followed by the Persian alternatives in multiple-choice format. Moreover, we asked the participants to leave each completed test under their chairs before answering the next test. By doing so, they could not return to the previous tests for clues.

Each test contained ten questions, and each correct answer was scored 1. The achievement tests measured the productive and receptive knowledge of the aspects and the scopes.

A. productive knowledge of orthography: In this test, each target word was pronounced twice. The participants had 10 seconds to write it down. An accurate version of the word dictated was scored 1.

B. receptive knowledge of orthography: The participants had to select the appropriate spelling of a word in this test, for example:

a) dreap b) drape c) drepa d) derap

C. receptive knowledge of meaning and form (recognition): In a multiple-choice test, the participants had to select a correct Persian definition for each target word. For example, for the word *Skull,* option A was the correct answer*:*

a) جمجمه *b)* کتاب *c)* ذره بین *d)* زنجیر

D. receptive knowledge of meaning and form (recall): In this test, participants had to write a Persian definition for each target word. They needed to recall the definitions.

E. productive knowledge of meaning and form (recognition): In a multiple-choice test, participants had to select a correct English form for a Persian definition. All alternatives were selected from the walkthrough. For example, for the word پرده, the correct English form was B:

a) Chain b) Drape c) Curtain d) Fence

F. productive knowledge of meaning and form (recall): The participants had to translate the Persian words into English. The participants needed to recall the English forms based on their Persian definition. In this test, an appropriate spelling was not considered important.

G. receptive knowledge of association: In this test, the participants had to cross out a word that had no association with other words. Alternatives were also selected from the walkthrough. For example, in this question, the word *sky* was irrelevant:

a) Glove b) Rubber c) Sky d) Fingers

H. productive knowledge of association: Although Webb (2007) differentiated between syntagmatic and paradigmatic associations, they were put in one category in this study. In this test, the participants had to write words they thought had associations with each target word. For instance, for the word *debris,* they could write either *dry, autumn* (syntagmatic association) or *leaves, tree* (paradigmatic). They were scored correct if their answers had even a loose association with the target words in each question. Moreover, in this test, an appropriate spelling was not considered important.

3.4. Procedure

First, to comply with the research ethics, we explained participants' rights in this study. Also, we asked them to fill in a letter of consent that had to be signed by them and by their parents. The day after, they sat the Oxford proficiency test, and also the vocabulary checklist test in a

60-minute session. Then they were randomly assigned to either the experimental group or the control group.

In a computer lab, at the beginning of the treatment session, we loaded the 5th chapter of the game to teach the experimental group participants how to play the digital game for almost 6 minutes. Next, the participants had to complete their DGBVL tasks by playing the digital game on 31 PCs in pairs. They were asked to do the tasks in pairs because "such tasks are an integral part of second language learning and are ubiquitous in language learning classrooms" (Cohen, 1987, p. 90). They had to read the walkthrough and follow its instructions for solving problems in the first chapter of the game (the DGBVL task). Moreover, the participants could use an online dictionary[2] to look up unknown words, even the target words. It should be noted that pairs often took turns randomly to play the game by asking their pairs to pass them the mouse to check their ideas for solving problems in the game. Since the first chapter of the game included unskippable video cut-scenes and puzzle mini-games for immersive entertainment, the whole gameplay session lasted for almost 60 minutes, and we were on-site during their gameplay to help with unexpected technical issues.

We also checked with the control group participants to see whether they knew exactly how to complete their RVLT at the beginning of the session. Control group participants were also busy with their RVLT in pairs on the same day in another room of the laboratory. Each pair had to fill in the blanks for completing ten sentences by selecting proper nouns from a list above the sentences. The list included the ten target words, and also two extra words as distractors. They could also use the same online dictionary to look for unknown words in their RVLT. Their session lasted almost 40 minutes. We also checked with them frequently to help them with any questions about the process. It is worth mentioning that the participants in both groups were exposed to the target words only once in their tasks.

Lastly, all participants sat for the achievement tests in the same laboratory three weeks later because "a delayed posttest of three weeks should be indicative of learning which is stable and durable" (Schmitt, 2010, p. 157). All participants sat for the achievement test at the same time. There was no time limit for completing both the tasks and the tests. We were present there to facilitate the process, and we collected the completed tests from the students' chairs.

4. Results

As the Kolmogorov-Smirnov test revealed that the test scores were not normally distributed (Table 5), the nonparametric Mann Whitney U test,

Table 5. The results of the normality test.

	Kolmogorov-Smirnov		
	W	df	Sig.
Receptive (Orthography)	.218	124	.000
Productive (Orthography)	.156	124	.000
Productive. Meaning (Recognition)	.197	124	.000
Productive. Meaning (Recall)	.180	124	.000
Receptive. Meaning (Recognition)	.209	124	.000
Receptive. Meaning (Recall)	.192	124	.000
Receptive (Association)	.189	124	.000
Productive (Association)	.149	124	.000
Receptive (Total)	.184	124	.000
Productive (Total)	.138	124	.000

Friedman Test, Wilcoxon and Bonferroni post hoc tests, and Spearman rho correlation (Hall, 2015) tests were used to analyze the data.

4.1. Does a DGBVL task make a significant difference in the acquisition of aspects, dimensions, and scopes of the word knowledge framework in comparison with a RVLT?

The first objective, which is the central core of the study, was an attempt to find whether the DGBVL task made any contributions to the acquisition of components of the word knowledge framework. To do this, the mean ranks of the experimental group performance in achievement tests were compared with the mean ranks of the control group performance in the 2 independent samples Mann Whitney U test (Table 6).

The results of the Mann Whitney tests indicate that the experimental group participants outperformed in all achievement tests. In other words, the results showed that the experimental group participants acquired both receptive and productive knowledge of different aspects and scopes of the target words more efficiently than their control group counterparts did. Moreover, the differences between their mean ranks at $P \leq 0.05$ were significant. Hence, the DGBVL task apparently has contributed to the acquisition of components of the word knowledge framework more efficiently than the RVLT did.

4.2. Which aspects, dimensions, and scopes of the word knowledge framework are acquired significantly more efficiently?

This question aimed to find which aspects, dimensions, and scopes of the word knowledge framework are acquired more efficiently through each task. Therefore, the mean ranks in each achievement test were compared with each other by the Friedman test followed by a Wilcoxon and Bonferroni posthoc test (Tables 7 and 8).

Table 6. Independent samples Mann Whitney U test results.

	Group	N	Mean Rank	Sum of Ranks	U	Sig.
Receptive (Orthography)	Exp	62	79.79	4947.00	850.0	0.00
	Con	62	45.21	2803.00		
	Total	124				
Productive (Orthography)	Exp	62	70.94	4398.50	1398.5	0.008
	Con	62	54.06	3351.50		
	Total	124				
Productive. Meaning (Recognition)	Exp	62	91.99	5703.50	93.50	0.00
	Con	62	33.01	2046.50		
	Total	124				
Productive. Meaning (Recall)	Exp	62	78.62	4874.50	922.5	0.00
	Con	62	46.38	2875.50		
	Total	124				
Receptive. Meaning (Recognition)	Exp	62	86.32	5352.00	445.0	0.00
	Con	62	38.68	2398.00		
	Total	124				
Receptive. Meaning (Recall)	Exp	62	73.44	4553.50	1243.5	0.00
	Con	62	51.56	3196.50		
	Total	124				
Receptive (Association)	Exp	62	79.76	4945.00	852.0	0.00
	Con	62	45.24	2805.00		
	Total	124				
Productive (Association)	Exp	62	76.01	4712.50	1084.5	0.00
	Con	62	48.99	3037.50		
	Total	124				
Receptive (Total)	Exp	62	82.10	5090.50	706.5	0.00
	Con	62	42.90	2659.50		
	Total	124				
Productive (Total)	Exp	62	81.23	5036.00	761.0	0.00
	Con	62	43.77	2714.00		
	Total	124				

Note: Exp = Experimental Group Con = Control Group level of Significance = $P \leq 0.05$

Table 7. Friedman test results (experimental group).

	Mean Rank	N	Chi-Square	df	sig
Productive (Total)	9.53	62	400.268	9	.000
Receptive (Total)	9.42				
Productive. Meaning (Recognition)	6.36				
Receptive. Meaning (Recognition)	5.55				
Receptive (Association)	5.45				
Receptive (Orthography)	4.32				
Productive (Orthography)	3.74				
Productive. Meaning (Recall)	3.74				
Productive (Association)	3.61				
Receptive. Meaning (Recall)	3.27				

The results show that, in general, the experimental group participants' performances in both receptive (total) and productive (total) tests are not significantly different. However, in particular their performance in the productive-recognition of form-meaning, at $p \leq 0.05$, is significantly different from their performances in the receptive-recognition of form-meaning and most of the other tests. In other words, the DGBVL task enhanced the acquisition of productive-recognition of form-meaning effectively.

Table 8. Wilcoxon and Bonferroni correction post hoc tests results (Experimental Group).

		Orthography (Receptive)	Orthography (Productive)	Meaning (Productive Recognition)	Meaning (Productive Recall)	Meaning (Receptive Recognition)	Meaning (Receptive Recall)	Association (Receptive)	Association (productive)	Productive (total)	Receptive (Total)
Orthography (Receptive)	Z		−2.531	−6.453	−1.327	−2.957	-.107	−5.715	-.075	−9.666	−9.674
	Sig.		0.511	0.000	8.297	0.140	41.176	0.005	42.298	0.000	0.000
Orthography (Productive)	Z	−2.531		−3.679	−4.822	-.631	−3.107	−3.530	−3.845	−9.669	−9.670
	Sig.	0.511		0.010	0.000	23.752	0.085	0.019	0.005	0.000	0.000
Meaning (Productive Recognition)	Z	−6.453	−3.679		−7.163	−5.550	−5.709	−2.250	−5.881	−9.671	−9.653
	Sig.	0.000	0.010		0.000	0.012	0.005	1.099	0.000	0.000	0.000
Meaning (Productive Recall)	Z	−1.327	−4.822	−7.163		−5.734	−2.169	−7.555	−2.150	−9.668	−9.670
	Sig.	8.297	0.000	0.000		0.000	1.353	0.000	1.420	0.000	0.000
Meaning (Receptive Recognition)	Z	−2.957	-.631	−5.550	−5.734		−3.086	−4.536	−3.243	−9.667	−9.669
	Sig.	0.140	23.752	0.012	0.000		0.091	0.000	0.053	0.000	0.000
Meaning (Receptive Recall)	Z	-.107	−3.107	−5.709	−2.169	−3.086		−6.417	-.315	−9.667	−9.673
	Sig.	41.176	0.085	0.005	1.353	0.091		0.000	33.889	0.000	0.000
Association (Receptive)	Z	−5.715	−3.530	−2.250	−7.555	−4.536	−6.417		−6.592	−9.667	−9.670
	Sig.	0.005	0.019	1.099	0.000	0.000	0.000		0.000	0.000	0.000
Association (productive)	Z	-.075	−3.845	−5.881	−2.150	−3.243	-.315	−6.592		−9.669	−9.669
	Sig.	42.298	0.005	0.000	1.420	0.053	33.889	0.000		0.000	0.000
Productive (total)	Z	−9.666	−9.669	−9.671	−9.668	−9.667	−9.667	−9.667	−9.669		−1.204
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		10.292
Receptive (total)	Z	−9.674	−9.670	−9.653	−9.670	−9.669	−9.673	−9.670	−9.669	−1.204	
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.292	

Table 9. Friedman test results (control group).

	Mean Rank	N	Chi-Square	df	sig
Receptive (TOTAL)	9.58	62	335.688	9	.000
Productive (TOTAL)	9.42				
Receptive (Association)	5.90				
Productive (Orthography)	5.29				
Productive. Meaning (Recognition)	4.94				
Receptive. Meaning (Recall)	4.43				
Receptive. Meaning (Recognition)	4.15				
Receptive (Orthography)	4.12				
Productive (Association)	3.96				
Productive. Meaning (Recall)	3.21				

For ensuring the efficiency of the DGBVL task in enhancing the acquisition of the productive dimension of form-meaning recognition, the control group's performances in each achievement test had to be compared (Tables 9 and 10).

The results show that, in general, the control group participants' performances in both receptive (total) and productive (total) tests are not significantly different. However, in particular, their performance in the receptive knowledge of association, at $p \leq 0.05$, is significantly different from their performances in the productive knowledge of association and most of the other tests. In other words, the RVLT enhanced the acquisition of receptive knowledge of association effectively.

Overall, it seems that the type of vocabulary learning task can play a significant role in the acquisition of dimensions, aspects, and components of word knowledge. Moreover, depending on the type of task, the weight of the effect can vary on the different aspects and scopes of the word knowledge framework.

4.3. To what extent are learned word knowledge framework components correlated to one another?

In theory, the components of the word knowledge framework are associated and may either support or hinder the acquisition of each other (Schmitt, 1998; Schmitt & Meara, 1997). We investigated the support for this theory by the Spearman rho correlation (Table 11).

The results of the Spearman correlation analysis showed positive significant (*) associations among nearly all components of the word knowledge framework. However, the results revealed that, at $p \leq 0.05$, the receptive knowledge of orthography is not in association with the productive recognition knowledge of meaning. Moreover, at $p \leq 0.05$, the highest positive correlation was found between the productive recall knowledge of the meaning and the productive knowledge of orthography (Table 12).

Table 10. Wilcoxon and Bonferroni correction post hoc tests results (Control Group).

		Orthography (Receptive)	Orthography (Productive)	Meaning (Productive Recognition)	Meaning (Productive Recall)	Meaning (Receptive Recognition)	Meaning (Receptive Recall)	Association (Receptive)	Association (productive)	Receptive (Total)	Productive (total)
Orthography (Receptive)	Z		−3.322	−2.237	−2.514	-.477	-.700	−4.041	-.328	−6.863	−6.850
	Sig.		0.040	1.138	0.536	28.496	21.763	0.002	33.436	0.000	0.000
Orthography (Productive)	Z	−3.322		−1.562	−4.822	−3.281	−2.851	-.794	−3.655	−6.865	−6.856
	Sig.	0.040		5.326	0.000	0.046	0.196	19.218	0.011	0.000	0.000
Meaning (Productive Recognition)	Z	−2.237	−1.562		−4.550	−2.887	−1.302	−2.564	−1.945	−6.855	−6.855
	Sig.	1.138	5.326		0.000	0.174	8.674	0.465	2.332	0.000	0.000
Meaning (Productive Recall)	Z	−2.514	−4.822	−4.550		−2.985	−3.900	−5.914	−2.525	−6.861	−6.852
	Sig.	0.536	0.000	0.000		0.127	0.004	0.000	0.521	0.000	0.000
Meaning (Receptive Recognition)	Z	-.477	−3.281	−2.887	−2.985		−1.701	−4.627	-.441	−6.860	−6.852
	Sig.	28.496	0.046	0.174	0.127		3.999	0.000	29.656	0.000	0.000
Meaning (Receptive Recall)	Z	-.700	−2.851	−1.302	−3.900	−1.701		−3.938	-.985	−6.860	−6.852
	Sig.	21.763	0.196	8.674	0.004	3.999		0.003	14.606	0.000	0.000
Association (Receptive)	Z	−4.041	-.794	−2.564	−5.914	−4.627	−3.938		−4.501	−6.862	−6.851
	Sig.	0.002	19.218	0.465	0.000	0.000	0.003		0.000	0.000	0.000
Association (productive)	Z	-.328	−3.655	−1.945	−2.525	-.441	-.985	−4.501		−6.860	−6.860
	Sig.	33.436	0.011	2.332	0.521	29.656	14.606	0.000		0.000	0.000
Receptive (total)	Z	−6.863	−6.865	−6.855	−6.861	−6.860	−6.860	−6.862	−6.860		-.623
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		24.002
Productive (total)	Z	−6.850	−6.856	−6.855	−6.852	−6.852	−6.852	−6.851	−6.860	-.623	
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.002	

Table 11. Results of Spearman correlation (experimental group).

		Orthography (Receptive)	Orthography (Productive)	Meaning (Productive Recognition)	Meaning (Productive Recall)	Meaning (Receptive Recognition)	Meaning (Receptive Recall)	Association (Receptive)	Association (productive)
Orthography (Receptive)	Correlation Coefficient		.532*	.074	.532*	.505*	.545*	.526*	.565*
	Sig.		.000	.567	.000	.000	.000	.000	.000
Orthography (Productive)	Correlation Coefficient	.532*		.426*	0.993*	.908*	.947*	.893*	.983*
	Sig.	.000		.001	.000	.000	.000	.000	.000
Meaning (Productive Recognition)	Correlation Coefficient	.074	.426*		.426*	.458*	.432*	.442*	.397*
	Sig.	.567	.001		.001	.000	.000	.000	.001
Meaning (Productive Recall)	Correlation Coefficient	.532*	0.993*	.426*		.908*	.947*	.893*	.983*
	Sig.	.000	.000	.001		.000	.000	.000	.000
Meaning (Receptive Recognition)	Correlation Coefficient	.505*	.908*	.458*	.908*		.877*	.991*	.897*
	Sig.	.000	.000	.000	.000		.000	.000	.000
Meaning (Receptive Recall)	Correlation Coefficient	.545*	.947*	.432*	.947*	.877*		.865*	.933*
	Sig.	.000	.000	.000	.000	.000		.000	.000
Association (Receptive)	Correlation Coefficient	.526*	.893*	.442*	.893*	.991*	.865*		.907*
	Sig.	.000	.000	.000	.000	.000	.000		.000
Association (productive)	Correlation Coefficient	.565*	.983*	.397*	.983*	.897*	.933*	.907*	
	Sig.	.000	.000	.001	.000	.000	.000	.000	

*= *significant; the sample size (N = 62).*

Table 12. Results of Spearman correlation (control group).

		Orthography (Receptive)	Orthography (Productive)	Meaning (Productive Recognition)	Meaning (Productive Recall)	Meaning (Receptive Recognition)	Meaning (Receptive Recall)	Association (Receptive)	Association (productive)
Orthography (Receptive)	Correlation Coefficient		.489*	.172	.095	.217	.126	.192	.313*
	Sig.		.000	.180	.463	.090	.328	.135	.013
Orthography (Productive)	Correlation Coefficient	.489*		.380*	.422*	.375*	.548*	.251*	.643*
	Sig.	.000		.002	.001	.003	.000	.049	.000
Meaning (Productive Recognition)	Correlation Coefficient	.172	.380*		.460*	.399*	.215	.223	.331*
	Sig.	.180	.002		.000	.001	.093	.082	.009
Meaning (Productive Recall)	Correlation Coefficient	.095	.422*	.460*		.568*	.541*	.308*	.375*
	Sig.	.463	.001	.000		.000	.000	.015	.003
Meaning (Receptive Recognition)	Correlation Coefficient	.217	.375*	.399*	.568*		.440*	.107	.342*
	Sig.	.090	.003	.001	.000		.000	.408	.006
Meaning (Receptive Recall)	Correlation Coefficient	.126	.548*	.215	.541*	.440*		.334*	.375*
	Sig.	.328	.000	.093	.000	.000		.008	.003
Association (Receptive)	Correlation Coefficient	.192	.251*	.223	.308*	.107	.334*		.371*
	Sig.	.135	.049	.082	.015	.408	.008		.003
Association (productive)	Correlation Coefficient	.313*	.643*	.331*	.375*	.342*	.375*	.371*	
	Sig.	.013	.000	.009	.003	.006	.003	.003	

*=*significant; the sample size (N = 62).*

In the control group analysis, the results of the Spearman correlation showed *weak* positive significant associations just among *some* components of the word knowledge framework. Moreover, at $p \leq 0.05$, the highest positive correlation was found between the productive knowledge of association and the productive knowledge of orthography.

Overall, the DGBVL task not only has enhanced the acquisition of the components, but it also has contributed to both forming and strengthening the associations among them.

5. Discussion

This study investigated the effect of a DGBVL task on the acquisition of word knowledge. The outcomes supported the previous findings in the DGBVL literature that had reported on the positive effect of DGBVL tasks (Janebi Enayat & Haghighatpasand, 2019; Sundqvist, 2019). Further, this study adds that a DGBVL task may enhance the acquisition of aspects, dimensions, and scopes of the word knowledge such as receptive, productive, recognition, and recall knowledge of orthography, meaning, and association. A good explanation for this positive effect can be the role of context. According to Webb (2007), contextualized vocabulary items can be acquired effectively due to surrounding contexts. Digital games provide a rich multimedia context, in which textual, pictorial, and auditory information are easily accessible for gamers (Janebi Enayat & Haghighatpasand, 2019). In such contexts the richness of input can support effective word knowledge acquisition. This idea is tenable by referring to the dual coding theory, which suggests that a simultaneous provision of visual and textual inputs leads to their long-term retention (Nation, 2001). Hence the experimental group participants during the game experienced the target words multidimensionally. In other words, they saw the textual forms and pictures and heard the pronunciations of the target words simultaneously. Thus, they would have stored combinations of rich information about every target word containing knowledge of the aspects, dimensions, and scopes and their associations, in their lexicon.

In the second question, we tried to find which aspects, dimensions, and scopes of the word knowledge framework are acquired more effectively. The results showed that the experimental group participants acquired the productive-recognition of form-meaning more effectively; however, the control group participants acquired the receptive knowledge of association more effectively. Considering the experimental group participants' performance, the precedence of form-meaning and recognition knowledge over other aspects and scopes is not a peculiar and

uncommon finding; besides, it supports the previous literature (Mondria & Wiersma, 2004; Webb, 2005). However, the precedence of productive knowledge over receptive knowledge of form-meaning recognition is rare in both vocabulary acquisition and DGBVL literature (De La Fuente, 2002; Sundqvist, 2019; Webb, 2005). Mondria and Wiersma (2004, p. 82) explain that "equivalence of type of learning and type of test [...] yield[s] better results than non-equivalence of learning and testing". Besides, in psychology, the transfer-appropriate processing hypothesis "emphasizes that the value of particular acquisition activities must be defined relative to particular goals and purposes. Furthermore, assumptions about the quality and durability of the resulting memory traces can only be determined relative to the appropriateness of testing situations" (Morris, Bransford, & Franks, 1977, p. 528).

Therefore, it can be inferred that the DGBVL task may be considered a productive rather than a receptive vocabulary acquisition task in nature because, concerning the transfer-appropriate processing, the participants had better performance in the productive-recognition of form-meaning test. This idea is tenable by drawing an analogy to the study by De La Fuente (2002). In her study, the participants who had the chance of negotiation plus production acquired productive knowledge of ten Spanish target words more effectively. She discussed how having the opportunity for talking about the target words might have enhanced the productive knowledge acquisition because the participants needed to use the target words productively. Similarly, the experimental group participants played in pairs, and they might have a chance to talk with each other about the target words and to produce them. Therefore, it might have provided them an opportunity to practice the target words productively, which was more beneficial for efficient vocabulary acquisition (Webb, 2007). Thus, the DGBVL task in this study might have been a productive vocabulary acquisition task.

In this case, we can speculate that the experimental group participants might have invested more of their attention to the forms rather than to the meaning. Duly they outperformed in the productive-recognition of form-meaning test. However, despite having a chance to complete the RVLT in pairs and the opportunity for talking, why the control group participants acquired receptive knowledge of association more effectively should be explored in the future by replicating this study and by comparing the opportunities and hindrances that each task may provide. However, by referring to the transfer-appropriate processing hypothesis, the efficient acquisition of receptive knowledge of association, by the control group participants, might be explainable. In their task, they needed to select a proper noun among 12 alternatives to complete each

sentence. Therefore, they were always comparing the nouns and their definitions to each other. Duly, they outperformed in the test of receptive knowledge of association.

Eventually, it should be noted that although we tried to avoid the effect of earlier tests on answering the later tests strictly, testing 10 target words eight times might have helped the participants to learn some words from the earlier tests and affected the answers. Hence, it can be speculated that, for example, if the DGBVL task encouraged the participants in investing most of their attentional sources in the forms, the participants might have also focused on the forms during their tests and picked some clues about the forms from earlier tests and used them to answer the forthcoming tests.

Finally, we found that although components of the word knowledge framework can be associated, and gains in one component can elevate gains in other associated components (Schmitt, 1998; Schmitt & Meara, 1997), these associations are highly susceptible to the type and the structure of vocabulary acquisition tasks. In this study, unlike with the RVLT, the DGBVL task helped the participants generate strong and positive associations among most components of the word knowledge framework. Schmitt and Meara (1997) and Schmitt (1998) have found that there are particular and strong associations between meaning and other components of the word knowledge framework. Hence, the DGBVL task might have enhanced the acquisition of meaning senses and developed the form-meaning links efficiently. The acquisition of other associated components was duly enhanced efficiently. Moreover, by comparing the amount and strength of the associations formed among the components by the DGBVL task with those formed by the RVLT, it can be realized that the nature of DGBVL task inputs is different from the regular paper-based vocabulary learning tasks. Also, it can be inferred that the richness and the distinctive nature of the DGBVL task inputs might have led to the efficient acquisition of the components and the strong links among the associated components.

6. Conclusion

This study has three major limitations. Firstly, the target words were selected among concrete nouns only. Therefore, the findings of this study may not extend to adjectives, verbs, and adverbs. Second, although tests sequencing and administration were done carefully, participants might have learned some words from the earlier tests and that could have affected the answers. Third, having only concrete nouns did not allow the effect of the DGBVL task on the other aspects such as grammar,

register, etc. to be investigated, and they should be considered in future studies.

Finally, the findings of this study illustrated how complex vocabulary acquisition is and how difficult it is to overcome such complexity. Based on the findings of this study, it seems that digital games can overcome the complexity of vocabulary acquisition to a remarkable degree. Therefore, we can conclude that language teachers can probably trust DGBVL tasks for teaching vocabulary because they can enhance the acquisition of most components of the word knowledge framework.

Notes

1. The information about the frequency profiles and the range of the nouns were obtained from https://www.lextutor.ca/vp/comp/.
2. https://www.oxfordlearnersdictionaries.com/

acknowledgements

I would like to acknowledge Mr. Ismael Farrokhian for his precious comments on this paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Amin Rasti-Behbahani is a postdoctoral researcher at University of Jyvaskyla. His research interests are digital-game-based learning, and vocabulary acquisition.

Maryam Shahbazi is a master graduate from Jyväskylä University of Applied Sciences and her research interest is digital-game-based learning.

ORCID

Amin Rasti-Behbahani http://orcid.org/0000-0002-1507-6986

References

Bahari, A. (2020). Game-based collaborative vocabulary learning in blended and distance L2 learning. *Open Learning: The Journal of Open, Distance and e-Learning*, 1–22. doi:10.1080/02680513.2020.1814229

Chen, H. J. H., & Hsu, H. L. (2019). The impact of a serious game on vocabulary and content learning. *Computer Assisted Language Learning*, 1–22. doi:10.1080/09588221.2019.1593197

Chen, M. H., Tseng, W. T., & Hsiao, T. Y. (2018). The effectiveness of digital game-based vocabulary learning: A framework-based view of meta-analysis. *British Journal of Educational Technology*, *49*(1), 69–77. doi:10.1111/bjet.12526

Cohen, A. D. (1987). Using verbal reports in research on language learning. In C. Faerch & G. Kasper (Eds.), *Multilingual matters, No. 30. Introspection in second language research* (pp. 82–95). Clevedon, England: Multilingual Matters.

De La Fuente, M. J. (2002). Negotiation and oral acquisition of L2 vocabulary: The roles of input and output in the receptive and productive acquisition of words. *Studies in Second Language Acquisition*, *24*(1), 81–112. doi:10.1017/S0272263102001043

deHaan, J., Reed, W. M., & Kuwada, K. (2010). The effect of interactivity with a music video game on second language vocabulary recall. *Language Learning & Technology*, *14*(2), 74–94.

Ebrahimzadeh, M., & Alavi, S. (2017). Readers, players, and watchers: Short and long-term vocabulary retention through digital video games. *International Journal of Applied Linguistics and English Literature*, *6*(4), 52–62. doi:10.7575/aiac.ijalel.v.6n.4p.52

Geranpayeh, A. (2003). A quick review of the English Quick Placement Test. *Research Notes*, *12*, 8–10.

Hall, J. L. (2015). *A guide to doing statistics in second language research using SPSS and R*. New York: Routledge.

Janebi Enayat, M., & Haghighatpasand, M. (2019). Exploiting adventure video games for second language vocabulary recall: A mixed-methods study. *Innovation in Language Learning and Teaching*, *13*(1), 61–75.

Jasso, P. R. (2012). A non-academic computer video game: Its effect on vocabulary acquisition in the EFL classroom (Published master's thesis). New York: Syracuse University.

Kirriemuir, J. (2002). The relevance of video games and gaming consoles to the higher and further education learning experience. Retrieved June 20, 2009, from http://www.jisc.ac.uk/index.cfm?name=techwatch_report_0201.

Krashen, S. (1989). We acquire vocabulary and spelling by reading: Additional evidence for the input hypothesis. *The Modern Language Journal*, *73*(4), 440–464. doi:10.2307/326879

Laufer, B., & Goldstein, Z. (2004). Testing vocabulary knowledge: Size, strength, and computer adaptiveness. *Language Learning*, *54*(3), 399–436. doi:10.1111/j.0023-8333.2004.00260.x

Lee, J. S. (2019). Informal digital learning of English and second language vocabulary outcomes: Can quantity conquer quality?. *British Journal of Educational Technology*, *50*(2), 767–778. doi:10.1111/bjet.12599

Meara, P. (1997). Towards a new approach to modelling vocabulary acquisition. In N. Schmitt & M. McCarthy (Eds.), *Vocabulary: Description, acquisition and pedagogy* (pp. 109–121). Cambridge: Cambridge University Press.

Mondria, J. A., & Wiersma, B. (2004). Receptive, productive, and receptive + productive L2 vocabulary learning: What difference does it make. *Vocabulary in a Second Language: Selection, Acquisition, and Testing*, *15*(1), 79–100.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Memory and Language*, *16*(5), 519–533.

Nation, I. S. P. (2001). *Learning vocabulary in another language*. Cambridge: Cambridge University Press.

Pivec, M., Dziabenko, O., & Schinnerl, I. (2003, July). *Aspects of game-based learning*. In 3rd International Conference on Knowledge Management, Graz, Austria (pp. 216–225).

Rabu, S. N. A., & Talib, Z. (2017). The effects of digital game-based learning on primary school students' English vocabulary achievement and acceptance. *Innovative Teaching and Learning Journal (ITLJ)*, *1*(1), 61–74.

Rasti-Behbahani, A. (2017, March). *The effect of video games on learning lexical word classes*. Presented at Nordic Educational Research Association Conference, Aalborg University, Denmark.

Richards, J. C. (1976). The role of vocabulary teaching. *TESOL Quarterly*, *10*(1), 77–89. doi:10.2307/3585941

Ringbom, H. (1987). *The role of the first language in foreign language learning* (Vol. 34). Clevedon: Multilingual Matters Ltd.

Schmitt, N. (1998). Tracking the incremental acquisition of second language vocabulary: A longitudinal study. *Language Learning*, *48*(2), 281–317. doi:10.1111/1467-9922.00042

Schmitt, N. (2010). *Researching vocabulary: A vocabulary research manual*. Hampshire: Palgrave Macmilan.

Schmitt, N., & Meara, P. (1997). Researching vocabulary through a word knowledge framework: Word associations and verbal suffixes. *Studies in Second Language Acquisition*, *19*(1), 17–36. doi:10.1017/S0272263197001022

Sundqvist, P. (2019). Commercial-off-the-shelf games in the digital wild and L2 learner vocabulary. *Language Learning & Technology*, *23*(1), 87–113. https://doi.org/10125/44674.

Sundqvist, P., & Wikström, P. (2015). Out-of-school digital gameplay and in-school L2 english vocabulary outcomes. *System*, *51*, 65–76.

Vahdat, S., & Rasti-Behbahani, A. (2013). The effect of video games on Iranian EFL learners' vocabulary learning. T*he Reading Matrix*, *13*(1), 61–71.

Webb, S. (2005). Receptive and productive vocabulary learning: The effects of reading and writing on word knowledge. *Studies in Second Language Acquisition*, *27*(01), 33–52. doi:10.1017/S0272263105050023

Webb, S. (2007). Learning word pairs and glossed sentences: The effects of a single context on vocabulary knowledge. *Language Teaching Research*, *11*(1), 63–81. doi:10.1177/1362168806072463

Zou, D., Huang, Y., & Xie, H. (2019). Digital game-based vocabulary learning: Where are we and where are we going? *Computer Assisted Language Learning*, 1–27. doi:10.1080/09588221.2019.1640745

Appendix A. Fill in the sentences by using the following words in the list.

Debris	Tag	Skeleton
Drape	Glove	Projector
Embers	Latch	Shack
Skull	Dossier	Matches

By using an x-ray, the human's … … … … structure is vividly visible.

Can I put a price … … on these products too?

Dr. West said the force of the blow had fractured Lewis' … … … … … ….

I wish you were at the … … … … …. with me last night

It is a good idea to take off the grating occasionally and clean out any … … ….

She searched her brains, staring into the glowing … … … … … … of the fire.

There was a big wooden door with a giant … …. on it to keep the door closed.

There's a slide … … … … … …. at the back of the hall which I can control from the front.

When she heard or saw nothing more, she dropped the net … … …. back into place, to disappear once more into the darkness of her house.

When you wash dishes, wear … … …. To protect your skin.