Evaluating the use of web-based games on students' vocabulary retention

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CHRONICLE	ABSTRACT
	Today, the use of technology has made education more enjoyable. Vocabulary retention becomes a challenging task for both teachers and learners. They may learn the vocabulary but may not retain it. Yet, the use of web-based games may assist them in maintaining words known for short and long-term retention. The current study was conducted to identify students' abilities in retaining words learned after they were assigned to play a web-based vocabulary learning game, namely OnVac. Both short and long-term retention were measured after they were required to play the game as a treatment. Also, the study investigated students' perceptions about the system operation of OnVac. The use of quantitative research design, particularly quasi-experimental research and survey showed gains in vocabulary retention among students for short and long-term retention. The study also found that OnVac can support vocabulary learning among students in their learning of the specialized vocabulary. In terms of the system operation, the participants reported that the tool could assist them in learning engineering and technology words as it was convenient to use. The study provided implications to the teaching pedagogy in that teachers need to be wise and analytical in developing the online game to assist learners in learning English specialized vocabulary.

1. Introduction

The use of technology has made education become more enjoyable in today's era. Games, particularly web-based games, are not 'alien' to anyone as the tools are used across all users' ages. The devices are resources for entertainment, but they can also serve as resources for education. There is evidence that games play a crucial role in assisting learners in learning vocabulary (Berns et al., 2013; Dalton & Grisham, 2011; Juffs & Friedline, 2014). Moreover, considerable literature has grown around the theme of online games and web-based games that one can play via the Internet. In learning vocabulary using games, connecting children to fun vocabulary games that are freely available online enables them to learn and enrich their vocabulary knowledge (Dalton & Grisham, 2011). The young learners in their study used free digital tools and internet resources to promote their engagement in vocabulary learning. Using the resources developed students' interest in the words they read, view and interact with.

Playing games enables adult learners to learn a vast amount of new vocabulary. Juffs and Friedline (2014) reported that one of the respondents in their study described that playing online games enabled him to "see" a lot of new vocabulary. He also preferred learning words with vocabulary games, although he felt it was sometimes difficult to understand them. Learning vocabulary by looking up words using online games enabled the Arabic and Korean students in their study to improve their

vocabulary learning. In addition, the use of VirtUAM enabled undergraduates to learn German vocabulary related to different supermarket products (Berns et al., 2013). The vocabulary presented in context integrated into VirtUAM made it easier to understand and learn new words. Students in their study learned the vocabulary according to the levels in the game. For instance, the first level introduces them to the basic vocabulary related to several supermarket products. For level two, quizzes are created whereby students need to complete them within a time frame. In short, four levels developed in VIrtUAM helped students understand and learn the target vocabularies presented in context.

Nevertheless, whether the games can retain the words learned before using them is particularly concerning. Previous research has been conducted on games' use in helping students retain target vocabulary (Balcı & Kartal, 2021; Honarzad & Soyoof, 2020; Shabaneh & Farrah, 2019). A comparison was made to the use of serious games (i.e. Influent) and mobile application game, namely AnkiApp, in learning vocabulary (Honarzad & Soyoof, 2020). The study found that the former was more powerful as a resource to help learners learn and retain the integrated vocabulary in serious games. The researchers concluded that serious games could be used to facilitate the acquisition and retention processes of learning new vocabulary among language learners better than the mobile app. Putting students in a fun and entertaining learning environment requiring them to play games can help them retain vocabulary. The research conducted by Shabaneh and Farrah (2019) found that the school children who were in the learning condition could retain the unfamiliar vocabulary they have learned in class. They could associate new vocabulary with their surroundings and, as a result, develop their communicative competence. It showed an increase in their abilities to learn and retain words learned as measured by the pre and post-tests.

Another study is interesting to discover that integrating WhatsApp with the peer-chain technique in teaching vocabulary could help learners retain target vocabulary. Balcı and Kartal (2021) found that such a technique proved more advantageous than helping students retain words using traditional paper-based word cards. The students in their study had the chance to repeat and be exposed to the target words frequently. As a result, it increased their interest, motivation, and responsibility in learning. Thus, the present study aims to identify students' abilities in retaining words learned after they were assigned to play a web-based vocabulary learning game, namely OnVac.

2. Literature Review

2.1 The importance of vocabulary learning

Second language readers see the importance of vocabulary knowledge to comprehend what they read. If they come across many unfamiliar words, the reading is not understandable, and when this occurs, readers do not obtain input. Research has shown a clear connection between reading and vocabulary knowledge; lack of vocabulary is the biggest obstacle in English as A Second Language (ESL) learners not reading strategies (Folse, 2004). Hence, the need to inhibit vocabulary knowledge for a learner's general proficiency in a Second Language (SL) is significant and is needed to communicate the SL successfully (Nakata, 2008).

Vocabulary learning is essential in most SL acquisitions. But for far too long, emphasis on ESL has long been on grammar. Interestingly, people can express themselves even with poor grammar, but a communication breakdown can occur with poor vocabulary. Therefore, Folse (2004) argues the rationale of learning vocabulary since he "You can get by without grammar; you cannot get by without vocabulary" (p.2). Nation (1990), the *guru* in vocabulary learning, states that vocabulary learning takes on two main approaches, namely direct and indirect vocabulary learning. If a focus is made on vocabulary, it is known as direct vocabulary learning. Still, if the learners' focus is on some other feature, such as the message that a speaker or writer conveys, then that is known as indirect vocabulary learning (Nation, 1990). ESL learners who have inadequate vocabulary face receptive and productive vocabulary learning difficulties. However, increasing a learner's vocabulary without paying attention to putting this knowledge to use may not help them. Therefore, a mechanism to enable the learning of vocabulary is needed and at the same time measure their understanding of the vocabulary they learned. Recall tests after a period of learning the vocabulary are necessary for successful indirect vocabulary learning.

2.2 Second Language (L2) vocabulary retention using web-based game

Vocabulary retention is the ability to store or remember as many words as possible by engaging in various learning activities (Stavy & NorsehaUnin, 2019). With the advanced use of technology, web-based games have been an integral part of learning a new language. It is becoming used in classrooms to enhance students' creativity and proficiency. In addition, the use of computers benefits students in second language classrooms in various ways (Folse & Chien, 2003). SL vocabulary acquisition with the use of online games has also been created. The multimedia vocabulary learning environment attempts to assist learners in seeing the connection between visual and verbal representational systems to increase vocabulary knowledge to bring positive effects on reading comprehension and the rate of speed for frequent word recognition (Tozcu & Coady, 2004). The study reported that such online games enabled students to create individualised vocabulary practice that allows "students to add words to an individualised list for further study or setting reminders to help with words by synonyms, antonyms, translation or paraphrase".

In another study, Horst et al. (2005) used concordance examples, online quizzes and online dictionaries, which assisted students in reinforcing their reading comprehension as well as vocabulary retention. Groot (2000) states the need to construct computer-assisted vocabulary learning environments with how words are acquired in mind in developing online vocabulary games. Such is necessary so that words learned by learners are strongly embedded for long-term retention. With this in mind, the researcher, therefore, develops a computer word-assisted program that encompasses noticing various properties of the new words in terms of morphological and phonological, semantic and syntactic sets to further use such words in different contexts, which illustrates various properties. In addition, such software should enable both implicit and explicit vocabulary learning and train students to be good vocabulary learners.

A recent study on computer-enhanced flashcard software programs measured students' vocabulary retention. Çakmak's et al., (2021) students assigned to the experimental group were required to use the program on their laptops, mobile phones, or other devices to learn vocabulary. In contrast, another group of students used the traditional learning of vocabulary. The post-test results showed that students in the experimental group outperformed their counterparts in the recall vocabulary test. Their study confirmed that the CALL-enhanced flashcard program could facilitate the learning and recall of vocabulary. Another study reported that using various web-based games available on the Internet positively impacts second language learners (L2) in their learning attitudes (Musa et al., 2021). The researchers found that the uses of the platforms improved students' performances in learning vocabulary. The researchers recommended that teachers need to be more open to using web-based vocabulary games in their pedagogy. The resources may contribute to the effectiveness of teaching English in general and to the learning of vocabulary, particularly among L2 learners.

3. Methodology

3.1 Research Design

The study uses a quantitative research design in collecting the data. Specifically, it uses quasi-experimental research since a True Experimental Design is impossible in educational settings. The academic session also does not permit the implementation of the latter design due to the difficulty in controlling the class schedule. A Nonrandomised Control Group, Pre-test Post-test Design is chosen as the most appropriate design type to collect the data in the current study (Fraenkel et al., 2012). Using this design, intact classes are used in that all students from one class are chosen as samples for the study.

3.2 Research Materials

The research material used in the study is OnVac. It is a web-based game developed to assist students in learning engineering and technology vocabulary. The vocabularies used in the game are selected from students' course books on electrical electronics, manufacturing, mechanical, civil, chemical, computer sciences and technology engineering. Students can learn almost 100 engineering and technology vocabulary by playing OnVac. Students can learn specialized vocabulary by playing the games by completing several vocabulary activities, such as Vacuum Beaker, Order Words, Parts of Speech, Fill-in-the-blanks, Synonym-Antonym Xplotube and Crossword Puzzle. Game developers were hired to develop the game while the researcher guided them with the pedagogy of learning that needs to be integrated into the game. Therefore, the development of the web-based game entails that the researcher has a series of consultations before it is completed. The preceding discussion explains the vocabulary activities in OnVac:

1. Vacuum-beaker

This activity enables learners to match words on the left of the screen to those on the right. They need to place a cursor on the target word and drag it into boxes on the right. Each correct score receives one point. In this activity, they may learn 'ductile', 'evolve', 'ferrite', 'rupture', etc.

2. Order-Words

Order-Words is an activity where words are scrambled, and learners are required to drag letters and place them in boxes provided. As an illustration, the word 'fulcrum' is scrambled and written as 'urulmc' while the letter 'f' is provided as a hint. Therefore, students need to arrange the letters to obtain the correct answer for the item. Besides that, another two hints are provided at the bottom of the screen. These hints define the scrambled words. 'Pivot',' soldered', 'sculpture' and 'pawl' are some words learners can learn in this activity.

3. Parts of Speech

In this activity, learners guess the parts of speech for a targeted word. For instance, they need to identify the part of speech for the word 'frictional' whether it is an adjective or adverb. A hint for learners to guess the part of speech for the targeted word is provided. A hint is also provided in that it gives an example of a sentence of how the target word is used in context.

4. Fill-in-the-blanks

In this activity, learners drag targeted words on top of the screen to boxes to complete a sentence. Answering an item, 'The _____ of the metal bar was inadaptable', they need to drag the word 'beam' to obtain a score.

5. Synonym-Antonym

The activity Synonym-Antonym enables learners to enrich their vocabulary knowledge of some of these words; 'intricate', 'insulate', 'repulsive', to name a few. In scoring a point for the word 'repulsive', learners need to move the cursor to the options' popular' or 'attractive' to identify its antonym—those who choose the word 'popular' score a mark.

6. Word Search

Word Search is another game in OnVac. Learners initiate the game by reading the list of words, 'accumulator', 'shaft', 'pulley' etc., placed on the right. Then they look at the puzzle containing the scrambled words on the left. These words are in all directions - vertically, horizontally, and backward. Students, therefore, move the cursor horizontally, diagonally or backwards by circling each letter of a word they found, and they can strike it off the list.

7. Xplotube

Playing Xplotube requires learners to type the correct letter in the blank spaces. If they choose the wrong letter, the letter chosen will not appear, and the tube explodes because they obtain wrong answers. However, if they get the answer right, the substance's colour in the tube stays the same as where it last stopped. Learners may ask for clues by clicking Hint #1 and Hint #2 in learning words such as 'macroscopic', 'oscillator', 'permeability' etc.

8. Crossword Puzzle

Playing Crossword Puzzle requires learners to insert appropriate letters into the spaces provided correctly. When they obtain a score, they can move to the next word in the crossword puzzle box. Some of the words they can learn from this activity are 'Impedance', 'tangential', 'prismatic'.

Fig. 1. Some activities in OnVac

3.3 Research Samples

Purposive sampling was employed in the current study. The sample of students selected for the study is based on the judgment that they represent the students' population in Universiti Malaysia Pahang, a technical university in Malaysia. There are 24 students involved in the current study. Eleven of them are from the Chemical & Natural Resources Engineering faculty, 12 students are from Civil Engineering & Earth Resources faculty, and one student is from the Mechanical Engineering faculty. Having 24 students in the study is appropriate as Gay (1999) and Green (2000) state that the least number of samples for the research design is 15 students.

3.4 Research Instruments

Two instruments were used in the current study. The first instrument is a set of tests; Pre-test, Immediate Recall test and Delayed Recall Post-test. The second instrument used in the study is a questionnaire. For the former, it is a test administered to students before they are assigned to play OnVac. The second test they take is the Immediate Recall Test, while the final test they sit is the Delayed Recall Post-test. The contents of the tests are the same. Yet, the researcher shuffles the numbering of the test items in the Delayed Recall Post-test. There are 76 questions in each of the tests. Each test is divided into two sections. The first section is divided into four parts – Part 1, Part 2, Part 3 and Part 4. Part 1 consists of 10 questions, Part 2 consists of 10 questions, Part 3 consists of 10 questions and Part 4 consists of 6 questions. Similarly, the second section is divided into Part 1, Part 2, Part 3 and Part 4. There are ten questions in each part.

In terms of the test format, Paul Nation's Vocabulary Level Test is used to guide the formulation of the test items. To illustrate, one of the questions, "The pipes may need ins_____against the cold". In attempting to answer this question, students will need to figure out the letters that fit the gap. The letters; 'i', 'n' and 's' are used as clues to answer the question. Therefore, letters u', 'l', 'a', 't' and 'e' should be written to answer this question correctly. For scoring the test items, all answers are scored as correct or incorrect for all the test items. Each correct answer is given one point. Any wrong answer receives a zero point. Similarly, unattended items are awarded zero points. All the tests contain 76 questions, and therefore, the maximum score is 76.

The second research instrument is a questionnaire. It is employed to gauge the students' evaluation of their perceptions on the system operation of OnVac. A Likert Scale is used to measure the responses by selecting any of these responses: '5' for Strongly Agree (SA), '4' for Agree, '3' for Neutral, '2' for Disagree and '1' for Strongly Disagree in responding their views concerning the system operation of OnVac. Five items are formulated in the domain.

3.5 Reliability and validity of the research instruments

The study employed content validity and face validity to assess its instruments. Content validity estimates how much a measure represents every element of a construct (Ary et al., 2010). For content validity, four lecturers from the Centre for Modern Languages and Human Sciences (CMLHS) were appointed to examine the suitability of the tests and questionnaire. They were also responsible for checking the face validity of the two research instruments. Their tasks were to check the operationalisation of the instruments to see "on its face"; they are a good translation of the construct (Fraenkel et al., 2012).

Meanwhile, Kuder-Richardson Formula 20 (KR-20) and Cronbach alpha were used to measure the quantitative data's internal consistency, namely the vocabulary achievement tests and the questionnaire. KR-20 was used to measure the former instrument since the tests are scored dichotomously (Ary et al., 2010). Table 1 indicates the computation of reliability coefficients of the three tests and the questionnaire after they were administered in a pilot study.

Table 1
Internal Consistency of Instruments Used in the Study

Instruments	Internal Consistency Methods	
	KR-20 Reliability Coefficient	Alpha Coefficient
Pre-test	0.77	-
Immediate Recall Test	0.78	-
Delayed Recall Post-test	0.77	-
Questionnaire	-	.801

3.6 Target Vocabulary

In selecting the target vocabulary for any study, Read (2000) argues that there is no standard approach to selecting target vocabulary for testing. However, they may be selected from class texts or activities (Schmitt, 1995). For this study, there are two stages in identifying the target vocabularies used for OnVac. The researcher identified students' core subject reference books at the first stage. Since there are seven faculties in the universities, seven core subjects' reference books were borrowed from the respective faculties. Following stratified random sampling, the researcher identified vocabularies in every twentieth of the books' pages. At least one target word was selected from the first twentieth page of the book. Then she would turn to the second twentieth page of the book to find another target word. The process continued until she was able to find 18 to 20 vocabularies from the core subjects' reference books. In general, 76 vocabularies were identified to be used in the online game. The second stage involved dividing the target words into eight activities. The activities are Vacuum-beaker, Order-Words, Parts of Speech, Fill-in-the-blanks, Synonym-Antonym, Word Search, Xplotube, and Crossword Puzzle.

3.7 Data Collection Procedures

In collecting the data for the current study, students were first briefed about the research procedures by the principal author. The procedure's objective was to ensure they could understand the process of collecting the data for the current research.

Then, they were required to take a pre-test. A week later, they were instructed to play OnVac during class hours so that the principal author could monitor them. She took at least 40 minutes, asking students to play the game. After that, the Immediate Recall Test was administered to the students. They took 30 minutes to complete the test. After a two-week break, a Delayed Recall Post-test was administered to the students. It has to be noted that during the break, the primary author warned the students not to access the game. This stage is crucial as it determines whether or not students could retain their vocabulary after playing OnVac. Also, the teacher-researcher could gauge their abilities in retaining the target vocabulary when they were given a break of no input or treatment.

3.8 Data Analysis Procedures

For the quantitative data, descriptive and inferential statistics were employed to analyse the data. The former was employed to analyse the preliminary data involving mean and standard deviation in reporting their results. Also, mean and standard deviation were employed to analyse the results obtained for learners' satisfaction with the system operation of OnVac. In addition, a paired-samples t-test was employed to examine significant differences in the pre-test and post-test. Eta squared ($\eta2$) is also presented when explaining the results before using paired sample t-tests. Its use is to inform the magnitude of the intervention effect (Pallant, 2005). The formula used to calculate the effect size and interpretation of the strength of the eta squared is in Table 2.

$$\text{Eta squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)}$$

where, t^2 is the square statistic value of t (t-statistics), (N1 + N2) is sum of the population of two groups.

Table 2
Interpretation of the strength of the eta squared

Size	Eta Squared
Small	0.01 or 1%
Medium	0.06 or 6%
Large	0.138 13.8%

4. Results

4.1 Learners' short-term retention playing OnVac

Students' short-term retention in playing OnVac was measured after sitting for the Immediate Recall Test. Table 3 shows the Immediate Recall Test results conducted after a week they sat for the Pre-test. The former test took place immediately after they played OnVac. In the table, the preliminary analysis shows a difference in mean scores between the Pre-test (M = 39.21, SD = 14.04) and the Immediate Recall Post-test (M = 60.88, SD = 8.77).

Table 3
Results of Mean and Standard Deviation for Pre-test and Immediate Recall Test

	Mean	N	Std. Deviation
Pre- test	39.21	24	14.04
Delayed Recall Post-test	60.88	24	8.77

Further, a paired sample t-test was conducted to evaluate the achievement of the number of words retained in the Immediate Recall Tests after playing OnVac. Table 4 shows that there was a statistically significant increase in their scores from the Pre-test (M = 39.21, SD = 14.04) to Immediate Recall Post-test (M = 60.88, SD = 8.77), t (23) = -6.75, p <.000. The eta squared statistic (0.48) indicated a large effect size.

Table 4
Results of the Paired Samples Test between Pre-test and Immediate Recall Test

	N	Mean	Standard Deviation	t	df	p	η^2 (eta Squared)
Pre-test	24	-21.67	15.74	-6.75	23	0.000	0.498
Immediate Recall Post-test	24						

4.2 Learners' long-term retention playing OnVac

The Delayed Recall Post-test measured the students' abilities to retain words for long-term retention. They took the test after they were given a two-week break in that they were not allowed to play the game anymore. There was also no intervention, for instance, classes or activities that were conducted to assist them in retaining words they have learned. The preliminary

analysis in Table 3 shows the results when Pre-test and Delayed Recall Post-test are compared to obtain the results for Delayed Recall Post-test. In Table 5, it shows that there was a difference in the mean scores between Pre-test (M = 39.21, SD = 14.04) and Delayed Recall Post-test (M = 60.80, SD = 6.70).

Table 5
Results of Mean and Standard Deviation for Pre-test and Delayed Recall Post-test

	Mean	N	Std. Deviation
Pre- test	39.21	24	14.04
Delayed Recall Post-test	60.80	24	6.70

Inferential statistics using a paired sample t-test was used to measure the students' ability in retaining words between the time they sat for the Pre-test and the Delayed Recall Post-test. The result in Table 6 indicates that there was a statistically significant increase in their scores from the Pre-test (M = 39.21, SD = 14.04) to Delayed Recall Post-test (M = 60.80, SD = 6.70), t (23) = -7.42, p <.000. The eta squared statistic (0.545) indicated a large effect size. The results of the Paired samples test between pre-test and delayed recall post-test are presented in Table 6.

Table 6
Results of the Paired Samples Test between Pre-test and Delayed Recall Post-test

	N	Mean	Standard Deviation	t	df	p	η² (eta Squared)
Pre-test	24						
Delayed Recall Post-test	24	-21.58	14.26	-7.42	23	0.000	0.545

4.3 Students' Perceptions on the System Operation of OnVac

A questionnaire was employed to measure the students' perception of the system operation of OnVac. The construct concerns the user control interface when they play OnVac. It allows players or learners to interact with the web-based game. The system operation must be integrated into games to prevent it from being a passive medium (Tyson, 2021). Table 7 shows the results of students' satisfaction levels in terms of system operations using OnVac. Item 5, concerning learners' ability to memorize the meaning of words learned using OnVac, obtained the highest mean (M = 3.71, SD = 0.75). The results implied that they perceived OnVac enabled them to retain the vocabulary they learned.

Meanwhile, Item 1, Item 2, and Item 5 had average scores concerning learners' perceptions of the friendliness of the interface, learning procedures in OnVac and convenience playing OnVac to assist them in learning engineering and technology vocabulary. It is worth noting that Item 2 is concerned with the navigation of the different games in OnVac. Sackett (2018) argues that navigation enhances users' experience, assists memory retention and promotes exploration and learning. Nevertheless, Item 3 pertaining to learners' ability in understanding the learning materials in OnVac had the lowest mean (Mean = 3.42, SD = 1.02). Table 7 presents the results of learners' satisfaction levels concerning system operations of OnVac.

Table 7
Results of learners' levels of satisfaction in terms of system operations playing OnVac

Nos.	Items	Mean	SD
1.	I think OnVac provides a friendly user interface	3.71	0.86
2.	I am very clear about the learning procedure of OnVac	3.71	0.91
3.	I can completely understand the learning materials in OnVac	3.42	1.02
4.	I think OnVac is a good learning tool to assist the learning of engineering and technology vocabulary	4.08	0.58
5.	I agree that learning engineering and technology vocabulary is very convenient using OnVac	3.71	0.75

5. Discussion

5.1 The use of OnVac to assist short-term vocabulary retention

In discussing the ability of OnVac to assist the students' short-term vocabulary, it showed that the web-based game was able to help learners memorise words for quite some time. They could store some targeted words and keep them in their minds for a short time. Their short-term memory was tested right after they played the online game in the study. The current study found that they could recall the words learned by answering the Immediate Recall Post-test. This finding supports previous research that playing games, particularly multimedia features, could facilitate learners to recall the vocabulary that learners have learned (Gorjian et al., 2011). Their study found that Iranian undergraduates could retain vocabulary for the short-term when web-based language learning was used among low and high-achievers for vocabulary retention and recall. The expository English text with various glosses or annotations for words in the form of text, graphics, video, and sound allowed them to retain the vocabulary learned.

Reflecting on the multimedia features in OnVac, the use of texts, colours, and sound helps learners remember the words learned. This finding is consistent with that of Mthethwa (2018), who found that text, sound, graphics, and video/animation

are common aspects of instructional practice when students learn vocabulary. His study that employed international students to assist them in learning vocabulary reported that the still picture combining text (target word) and sound (pronunciation of the target vocabulary) enabled them to retain the words learned. Although the students could understand and retain the words learned, they made mistakes in structuring sentences. In other words, the students' productive vocabulary knowledge needed improvement. Mthethwa (2018) concluded that to retain his students' vocabulary, seeing or hearing the target vocabulary twice seemed insufficient for vocabulary recall.

5.2 The use of OnVac to assist long-term vocabulary retention

Using OnVac in this study corroborates Franciosi, Yagi, Tomoshige, and Ye (2016), students' abilities in retaining target vocabulary for long-term retention. Their study reported that the simulation games enabled their students to improve long-term retention of the target vocabulary compared to the students who did not use the games. In particular, students who were put in the experimental group outperformed those in the control group when both groups took a delayed post-test 11 weeks after the former group of students received their treatments. Specifically, the use of Quizlet among the English as a Foreign Language (EFL) Japanese learners proved that simple, yet user-friendly simulation games assisted them in learning 29 targeted vocabulary. Their study concluded that Quizlet has its educational benefit since it can develop the acquisition of foreign language vocabulary among learners.

The current results on the significant differences in the long-term retention among students also reflected those of Smith et al. (2013), who found that playing vocabulary games on the web promoted long-term retention among learners in their vocabulary learning. Their study found that students in the computer game condition benefited from vocabulary learning compared to the control condition group. In particular, it was found that the students could retain words for long-term retention better when computer games using inferencing in eBooks were used compared to hardcopy booklets. The eBooks helped students' long-term retention of the vocabulary they learned since they were inferences about the story they were reading.

Students in the current study were assigned to play OnVac on their own. It proved they were able to retain the words learned. However, this finding has important implications for developing a multiplayer game to gauge whether or not students are still able to retain words for long-term recall. Tseng et al., (2020) found that retention is much easier to achieve when students work in a group. In their study, using a 3D vocabulary learning program among EFL young learners assisted them to retain words for a long time since they could learn collaboratively from their peers. It is because they could learn on their own and at the same time with their peers and the 3D simulations. The combination of learning that involved deeper cognitive processing and higher learner engagement compared to working alone fostered their abilities in retaining the target words for long-term retention. The researchers concluded that using a 3D vocabulary learning program by pairing learners could nurture vocabulary growth among these young learners.

5.3 Learners' Satisfaction on the System Operation of OnVac

In terms of OnVac's system operation, generally, it was found that participants could memorise the meaning of words learned using the tool. This finding agrees with Liu and Chu's (2010) study in that students could improve their ability to retain words better than using the non-gaming method. Their study showed that using a ubiquitous learning environment, Handheld English Language Learning Organization (HELLO), enabled students to achieve better learning outcomes and motivate the latter in learning more positively. In their study, the student's abilities to retain words learned were indirectly measured when they engaged in various listening and speaking activities.

In the current study results, students liked the system operation in OnVac as it provided easy learning procedures. Such was true as they could play one activity and then play another activity in OnVac. When they complete the activity, scoring will later appear on the screen. The system in the game interacts with one another so that their learning can be facilitated. It is encouraging to compare this explanation with that found by Mulder et al. (2021). The serious game-based word-to-text integration, namely Words&Birds consists of a system operation that matches the learners' skill levels with the items they need to learn. Using computerized adaptive testing in Item Response Theory, the algorithm was created in such a way that it could estimate the students' skills and item difficulty simultaneously. Upon completing the games, they obtained their respective scores.

Concerning Item 3 on students' inabilities in understanding the learning materials in OnVac, these results might partly be explained by the challenges that students faced completing a particular activity. For instance, the system's operation is such that when students play the activity, Xplotube, they might feel unmotivated since wrong answers could easily 'kick' them from completing the activity. Their inability to spell a target word correctly at the blank spaces might make them less interested in completing other activities after playing Xplotube. This outcome contradicts Wu and Huang (2017), who found that students' learning motivation and interest increased when they played a mobile game-based English vocabulary practice. Their system operation transformed vocabulary learning from dreary memorization to game-based learning. Partly, such might be the results of integrating various multimedia in their study that could enhance the learners' vocabulary memory.

6. Conclusion and Implication

This study presents several pedagogical implications for vocabulary learning and retention. First, OnVac can be utilized as an online environment to facilitate learning engineering and technology vocabulary. Since the vocabularies are selected from students' core engineering and technology reference books, it seemed that OnVac might encourage them in understanding their core subjects better. Second, the study showed that OnVac enables students to retain vocabulary for short-term and long-term recall. The eta squared statistic in both Immediate Recall Test and Delayed Recall Post-test indicated a large effect size; 0.66 and 0.55, respectively. Playing OnVac enables students to recall words since they can play the activities as often as they prefer. Finally, the study serves as guidelines for teachers of L2 to be better able to make pedagogically wise decisions in developing online games in language classes. The limitations of the present research indicate that there is a need to replicate the present study to validate its findings. Further study may also have a larger scale to reach a broader student population.

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