ISSN 1799-2591 (print); ISSN 2053-0692 (online)
Theory and Practice in Language Studies, Vol. 16, No. 11, pp. 3714-3725, November 2026
DOI: https://doi.org/10.17507/tpls.1611.05

Effects of Digital and Non-Digital Game-Based Instruction on Vocabulary Acquisition Among Thai Secondary School Learners

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Abstract—**This study investigated the effects of digital game-based learning (DGBL) and non-digital game-based learning (NDGBL) on vocabulary acquisition among Thai secondary school EFL learners. A quasi-experimental design was employed with 75 seventh-grade students from two intact classes, assigned to either a digital or a non-digital game-based instructional group. Vocabulary knowledge was measured across four dimensions: receptive recognition, receptive recall, productive recognition, and productive recall. Pre- and post-test data were analysed to assess vocabulary acquisition. The findings revealed that both instructional approaches significantly improved learners' receptive and productive vocabulary knowledge of form-meaning connections. No statistically significant differences were found between the two instructional modes, suggesting comparable usefulness. Furthermore, results across test types demonstrated a clear developmental progression from receptive recognition to productive recall, reinforcing the view that vocabulary acquisition is incremental and multidimensional. The questionnaire results further indicated that students held positive perceptions of both approaches, particularly regarding engagement, enjoyment, and their usefulness in strengthening form-meaning connections. This study offers substantial evidence that both digital and non-digital game-based learning are effective, learner-centred methodologies for improving vocabulary knowledge and retention in EFL contexts. The findings also suggest that the game-based instruction influences learning outcomes more than the technological medium per se; therefore, teaching strategies with efficient values can be implemented regardless of whether the games are digital or non-digital.**

Index Terms—**vocabulary knowledge, digital game-based learning, non-digital game-based learning, vocabulary retention, Thai secondary school EFL learners**

I. Introduction

Vocabulary knowledge is widely perceived as an essential element of effective second and foreign language (L2) learning because students' ability to comprehend and express themselves relies on vocabulary knowledge in both spoken and written modalities (Afzal, 2019; Schmitt, 2010). It is frequently construed as a multifaceted construct of word knowledge, including form, meaning and use. These components can be developed both receptively and productively (Nation, 2022). Receptive vocabulary knowledge refers to learners' recognition and comprehension of word form and meaning while listening or reading, whereas productive knowledge refers to the ability of retrieving, producing, and appropriately using words when speaking or writing (Ha, 2021; Janebi Enayat & Derakhsan, 2021; Sukying, 2025).

At the heart of this multidimensional framework sits a well-established mechanism in vocabulary development: creating strong form-meaning connections. Recognition of form-meaning connections is a critical step in acquiring vocabulary and achieving fluency in the target language (Laufer & Goldstein, 2004; Qian & Lin, 2020). As vocabulary acquisition is believed to be a gradual process, empirical findings indicate that form-meaning associations are typically acquired first, with productive control developed at subsequent stages (González-Fernández & Schmitt, 2020; Zhong, 2018). Additionally, these connections are reinforced, and the loss of vocabulary can provide long-term support (Teemueangsai et al., 2025). Thus, this connection between form and meaning aids vocabulary learning and other aspects of language, such as listening comprehension, reading ability, and general language proficiency (Cheng & Mathews, 2018; Webb, 2009). Thus, developing robust and durable form-meaning connections is one of the most important goals of successful vocabulary instruction in EFL contexts.

While form-meaning connections are essential for vocabulary learning, conventional classroom practices typically fail to provide sufficient meaningful exposure and repeated retrieval opportunities necessary for integration. Secondary school learners in many EFL contexts often face challenges with spelling, pronunciation, and word recognition that seriously inhibit vocabulary development (Afzal, 2019). Nonetheless, a number of commonly used instructional approaches still rely predominantly on rote memory, isolated word lists and word-for-word translation methods, which provide low levels of vocabulary learning and weak transfer to communicative performance (Nation, 2022; Matwangsaeng & Sukying, 2023).

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However, these methods support the immediate recognition of a word's meaning but fail to give learners a thorough understanding of vocabulary and its use across contexts. This limits the learners' ability to use words both accurately and meaningfully (Stæhr, 2008; Webb, 2009). Therefore, although they are exposed to English in the classroom, most learners do not acquire enough vocabulary knowledge to be academically successful (Alqahtani, 2015; Saengpakdeejit, 2014; Teemueangsai et al., 2025). This requires interactive, context-rich pedagogical approaches. Activities such as games, collaborative tasks, and real-world applications promote meaningful learning and help encode vocabulary in long-term memory.

Due to these limitations, game-based learning (GBL) has gained significant attention as a pedagogical approach for increasing the vocabulary. Research has demonstrated that games can play a valuable role in increasing student interest, motivation and engagement with learning, especially among young students (Russell, 2015; Teemueangsaiet al., 2025). Games embed vocabulary input in achievable, interactive tasks that encourage reflective encoding of lexical items as they are retrieved and explored in meaningful contexts (Coyne et al., 2009; Teemueangsai et al., 2025). Together, these characteristics combine to reinforce the connection between form and meaning, which is necessary for effective vocabulary learning and long-term retention.

Both digital and non-digital game-based approaches in the Thai EFL context provide important but diverse affordances. Given the greater accessibility of digital technologies, as well as their multimedia-rich and interactive nature (Chang & Hwang, 2019; Kohnke et al., 2020; Zou et al., 2021), digital games have rendered themselves an attractive medium for learning new vocabulary. Digital games have the potential to benefit learners' attention, noticing, and remembering of language forms as well as form-meaning mappings through multimodal input, immediate feedback and gamified elements like scoring systems and rewards. These affordances have been demonstrated to promote engagement leading to short-term vocabulary gains in recognition-based learning tasks (Zou et al., 2021). Through gamified experiences, learners can reignite enjoyment and immersion in the process of vocabulary acquisition.

In technologically inaccessible contexts, non-digital games offer a readily available and pedagogically useful choice (Akdogan, 2017). Activities such as board games, card games and role-play tasks can encourage real-world contact, peer negotiation and embodied learning. These characteristics may stimulate deeper cognitive processing, collaborative scaffolding, and productive use of the language and lead to improving learners' grasping and retention of language concepts (Ke et al., 2015; Teemueangsai et al., 2025). In brief, they reinforce and keep form-meaning mappings that are crucial for successful language learning and allow learners to practice their skills in real-world situations.

While research supporting the effectiveness of digital game-based learning for vocabulary growth has expanded, relatively few studies have directly compared the effects of digital and non-digital game-based approaches in an analogous instructional context. The gap is noticeable in secondary English education within Thailand, especially outside metropolitan areas, where traditional instructional practices often remain, and knowledge of the capacity of digital game-based learning to further students' vocabulary acquisition compared to traditional methods remains limited. This highlights the need for empirical inquiries into how various modalities of game-based instruction will provide aid with vocabulary development, specifically production and retention of semantic form-meaning linkages.

Subsequently, this study investigated the effects of two different modes of game-based instruction, digital and non-digital, on vocabulary learning of Thai secondary school EFL learners. It aims to reinforce learners' form-meaning linkages across both receptive and productive domains jointly, as well as the extent to which learners perceive these instructional procedures as language learning strategies. As such, this study will provide theory-grounded, classroom-relevant knowledge on effective vocabulary instruction to aspiring practitioners in implementing more student-engaged, equitable and context-oriented practices in EFL contexts. The following research questions guide the study accordingly:

1. What are the effects of digital and non-digital game-based instruction on Thai secondary school learners' vocabulary knowledge?
2. What are Thai secondary school learners' perceptions of using digital and non-digital games for vocabulary learning?

II. Literature Review

A. Vocabulary Knowledge

Vocabulary knowledge is widely recognised as a crucial component of language teaching and learning. Nation (2022) described the multi-component nature of vocabulary knowledge, comprising form, meaning, and use. Form encompasses spoken and written forms of a word and word parts such as prefixes and suffixes. Meaning includes knowledge of form-meaning connections, concepts and referents, and word associations. Use comprises grammatical functions, collocations, and constraints on use, such as register and frequency. These components are further classified as receptive and productive word knowledge (Nation, 2022). Receptive word knowledge is the ability to recognise a word, at least to some extent, and to retrieve its meaning through listening and reading. In contrast, productive word knowledge is the learner's ability to recall and use a word in speaking and writing. Mastery of these components enables learners to select, interpret, and use vocabulary appropriately across a range of communicative contexts.

Vocabulary development is a gradual process that unfolds through repeated exposure to and engagement with lexical items (González-Fernández & Schmitt, 2020; Nation, 2022; Schmitt, 2010). This development encompasses both

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vocabulary breadth, the number of words a learner knows, and vocabulary depth, the richness of understanding of each word, including its meanings, usage, and collocational patterns. Together, both breadth and depth of vocabulary knowledge are critical to effective language use and overall proficiency.

B. Game-Based Learning

Game-based learning is a creative pedagogical approach that has been developed. It is also used to improve learning in subjects, including maths, language, computing, science, and social studies. It offers the theoretical background with multiple practical implications for effective learning outcomes (Liu et al., 2020). It also decreases anxiety, increases motivation and helps students link what they learn to practice (Chang & Hwang, 2019; Kohnke et al., 2020), thereby improving the educational experience and retention of knowledge. Teemueangsai et al. (2025) argued that game-based learning is an appropriate approach to learning vocabulary. By participating in the tasks that interest students and thinking about words, they are growing their attention to target words, which enhances retention and recall (Coyne et al., 2009). Such activities will also help the teacher to develop an environment for meaningful low-stakes learning, which allows students a safe space that eases anxieties around them and engages them in wanting to participate and take risks in their learning. Generally, based on the level of use with information technology, it is either digital game-based learning (DGBL) or non-digital game-based learning (NDGBL).

Digital Game-Based Learning (DGBL) involves the use of digital games for embedding educational content in a video or board game format that supports teacher instruction and learner engagement and academic performance (Ke et al., 2015; Kohnke et al., 2020). DGBL can be described as an instructional approach that leverages the motivational affordances of digital platforms, such as mobile applications, computer games, and console-based systems, to facilitate learning. DGBL covers a broad range of formats from interactive simulations to mobile vocabulary apps, offering many opportunities for implementing any one of them. Involvement in audiovisual resources (audio, animation and instant feedback) will engage learners because of multimodal processing, which helps in vocabulary learning (Zou et al., 2021).

Non-Digital Game-Based Learning (NDGBL), by contrast, refers to the use of physical and tangible materials, including board games, flashcards, card-sorting activities, and teacher-designed tools. The approach focuses on learning through experience and social interactions through using tactile techniques, face-to-face interactions and joint problem-solving (Ke et al., 2015). In addition, NDGBL incorporates important elements of games, such as goal orientation, competition, immediate feedback and collaboration, which enhances autonomy, motivation and the meaningfulness of engagement with the material (Park & Lee, 2017).

C. Theoretical Frameworks

The three interconnected theoretical perspectives on which this study is built are dual coding theory (DCT), cognitive load theory (CLT), and constructivist learning theory (CTL). According to dual coding theory (Paivio, 1971), information is processed through two connected channels, verbal and nonverbal (visual), and is better learned when both are activated simultaneously. In game-based learning, both digital and non-digital games encode vocabulary across multiple modes, including images, sounds, and contextualisation. Such strategies help learners construct more comprehensive cognitive-semantic networks of lexical items and deepen their conceptual knowledge of words.

The salient cognitive load theory (Sweller, 1994, 2011) holds that optimal instruction rests on minimising extraneous cognitive demand and facilitating deep or meaningful processing. As with game-based learning, both digital and non-digital games help students acquire new vocabulary by organising information into well-structured, meaningful units, consequently reducing extraneous cognitive demand and making processing more efficient. Digital games include audio, video, and immediate response and interactivity, which, through dual-channel processing (Chandler & Sweller, 1991), can complicate simple linguistic input. Likewise, more traditional games, e.g., board games and card-based activities, deliver knowledge in a structured, interactive way that focuses learners on relevant linguistic features while imposing minimal cognitive demands. Both modalities aim to orient learners without overloading them with information, using tasks that distil vocabulary learning goals into clear form-meaning relationships. The literature suggests that well-designed, simplified instructional resources can also help reduce cognitive demand and enhance retention and comprehension of material (Leahy & Sweller, 2011).

Additionally, constructivist learning theory holds that learners actively build knowledge through interaction with their environment, rather than simply receiving information (Piaget, 1952, 1970; Vygotsky, 1978). As such, learning is a process of searching, interrogating and introspecting to gradually build understanding. Whenever we interact with our peers and teachers, they support cognitive development, as knowledge can be co-constructed through sociocultural engagement (Piaget, 1985). This differs from the use of games in word learning, where learners are active agents who construct their own meaning through problem-solving, experimentation and joint effort. Games offer engaging, interactive tasks that reflect authentic language use, helping learners internalise vocabulary through relevant contextual use. This enhances higher-order thinking and vocabulary retention by enabling learners to elicit items from memory through social interaction.

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III. Research Methods

A. Research Design

The study was conducted in a positivist research paradigm, in line with the assumption that relationships between cause and effect can be objectively investigated based on systematic measurement and statistical analysis. In accordance with this viewpoint, the present study utilised a quasi-experimental research design to examine the impact of game-based instruction employing digital and non-digital games on receptive and productive vocabulary knowledge in Thai secondary school learners. Two intact classes were assigned to either of the experimental conditions and provided with digital or non-digital game-based vocabulary instruction. Equivalent pretests and posttests were administered to measure vocabulary gains. Moreover, the aspect of learners' own perceptions towards instructional approaches was captured using a structured questionnaire. Standardised instruments facilitated objective assessment of instructional effects, providing quantitative evidence of learning outcomes and students' perceptions (Creswell & Creswell, 2018).

B. Participants and Setting

The present study included 75 Thai students, aged between 12 and 13, from two intact classes at a secondary school in northeastern Thailand. The two classes were assigned randomly to digital game-based learning (DGBL) (n = 36) and non-digital game-based learning NDGBL) (n = 39) groups. All participants learned English as a foreign language (EFL) and enrolled in a supplementary English course. All participants, who partook in the study, were familiar with smartphones and reported regular use of digital devices. To evaluate the effectiveness of both teaching methods, the results of the institutional English examination showed no statistically significant differences, suggesting that participants from both digital game-based learning (DGBL) and non-digital game-based learning NDGBL) groups had a similar level of English proficiency before the intervention. Furthermore, the intervention lasted 8 weeks, with game-based instructional activities, totaling 24 hours of instruction delivered by the same teacher.

C. Games as Intervention

(a). Digital Games as Instructional Intervention

Digital games were used as an instructional intervention. They were defined as technology-enhanced, goal-oriented learning activities. These activities required learners to participate actively in vocabulary learning through interactive tasks delivered on digital devices. These activities were designed to strengthen form-meaning linkages of a word through recurrent experience, retrieval exercise, and meaningful visits. The digital game-based learning participants received teaching using four platforms: Blooket, Gimkit, ZEP Quiz, and Wordwall. These platforms were selected because they provide (a) repeated practice opportunities, (b) immediate and informative feedback, (c) multimodal input mingling text, images, and sound, and (d) interactive and competitive features that help maintain learners' motivation and attention. Collectively, these characteristics are consistent with principles of vocabulary learning, particularly noticing, retrieval, and consolidation (Nation, 2022).

(b). Non-Digital Games as Instructional Intervention

Non-digital games were implemented as a teaching method to strengthen learners' knowledge of form-meaning linkages and improve vocabulary acquisition. In this study, non-digital games were defined as hands-on, cooperative, and movement-based learning activities. The activities were designed to promote vocabulary learning through repeated exposure, retrieval exercises, peer collaboration, and meaningful communication. The participants in the non-digital game-based learning group partook in four activities: board games, card games, Rip and Run, and word unscramble games. These non-digital games were applied due to their features, which encompass active participation and social interaction in low-anxiety learning atmospheres. Such features accord with research (Nation, 2022; Teemueangsai et al., 2025), indicating that movement-based and collaborative games can improve memory retention, word recognition, and learner motivation by engaging social, cognitive, and kinesthetic processes simultaneously.

D. Instruments

Four vocabulary knowledge tests, including receptive recognition, productive recognition, receptive recall, and productive recall, were used to assess students' vocabulary knowledge before and after the intervention. A questionnaire was also administered to investigate perceptions of using digital and non-digital games for vocabulary learning. The following sections provide detailed information on the instruments.

(a). Receptive Recognition Test

This test was a multiple-choice assessment in which participants selected the correct meaning of the target word. It consisted of 20 items selected from the target word lists and took about 20 minutes. The test aimed to measure the written receptive vocabulary of both L1 and L2 students. One point was awarded for each correct answer. For example:

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Directions: Choose the correct meaning of the given word.		**Answer**	**Point**
1.	**brave:** The <**brave**> firefighter ran into the burning house to help the family.		
a)	เป็นมิตร	incorrect	0
b)	กล้าหาญ	correct	1
c)	ร่าเริง	incorrect	0
d)	มีน้ำใจ	incorrect	0

(b). Receptive Recall Test

The Receptive Recall Test presented participants with 20 questions, each requiring them to match a word to its correct meaning. It was divided into two columns: the left column contained L2 meanings, and the right column contained target words and definitions. Points were awarded to participants for each correct response. For example:

Instructions: Match the words. Write the number of that word next with the correct definitions.

Meaning		**Target Word**
1.	พ่อ	
2.	แม่	____5____ **husband:** a man who is married to a woman
3.	ลูกชาย	____2____ **mother:** a woman who has a child or children
4.	ลูกสาว	____4____ **daughter:** a girl who is the child of her parents.
5.	สามี	
6.	ภรรยา	

(c). Productive Recognition Test

The Productive Recognition Test, adapted from Laufer and Nation's (1995) Vocabulary Production Test, was designed and presented in a fill-in-the-blank format, requiring learners to write the target words. The test measured the extent to which students could spell the target word correctly in response to the given sentence or definition. There were 10 sentences. One point was awarded for each correct spelling, and no points were awarded for incorrect spelling. Minor spelling mistakes that did not change the meaning of the word were ignored. For example:

Directions: Complete the sentence with the correct words that match the given meanings.

1. The **d**_____ runs and plays in the yard. (สุนัข)

   Answer: The ***dog*** runs and plays in the yard. (สุนัข)

(d). Productive Recall Test

The productive recall test is adapted from Laufer and Goldstein (2004) and Webb (2009). It consisted of 15 items and was designed to assess students' understanding of word meanings. In this test, students were given Thai definitions and asked to recall and write the corresponding English words. Students received 1 point for a fully correct answer, 0 points for a blank or incorrect answer, and 0.5 points if part of the morpheme was correct. An example of the test format is shown below.

Directions: *Complete the word from the given meaning.*

	Word Questions	**Answer**	**Correct Answer**	**Point**
1	หมู่บ้าน	**v** *illage*	village	1
2	สวย	**b** *eauty*	beautiful	0.5
3	ยางลบ	**e** _____	eraser	0

(e). Questionnaire

This study utilised two perception-based instruments: the *Digital Game-Based Learning Questionnaire* and the *Non-Digital Game-Based Learning Questionnaire*. Each questionnaire was designed to investigate students' perceptions of the instructional effectiveness of digital and non-digital game-based learning in improving vocabulary knowledge. The questionnaires focused on students' understanding of form-meaning connections developed during the intervention, across both productive and receptive aspects. Responses were rated on a 5-point scale, ranging from "strongly disagree" (1) to "strongly agree" (5). To ensure clarity and accuracy, the questionnaires were administered in Thai, allowing participants to fully comprehend the questions.

E. Data Collection

This study employed a three-stage data collection procedure to examine vocabulary acquisition and retention. In Stage 1 (Week 1), participants completed a pre-test to establish their baseline vocabulary knowledge. The assessment comprised four test types designed to measure both receptive and productive dimensions of vocabulary knowledge. Stage 2 (Weeks

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2-9) involved the instructional intervention, during which students in each group participated in one hour of game-based learning activities per session, either digital or non-digital, focusing on specific vocabulary topics. Interactive learning techniques were embedded throughout this phase to promote sustained engagement and repeated exposure to target vocabulary. Finally, in Stage 3 (Week 10), a post-test was administered using the same assessment format as the pre-test to evaluate immediate learning gains. In addition, a questionnaire was distributed to gather students' perceptions of the intervention and their experiences with digital and non-digital games as instructional tools. Each test was designed to be completed within 60 minutes, with balanced item distribution and comparable difficulty levels across test types to ensure fairness. This structured, multi-stage design enabled a comprehensive evaluation of the intervention's effectiveness in enhancing vocabulary acquisition and retention.

F. Teaching Procedure

The instructional design was adapted from the vocabulary-teaching principles proposed by Gains and Redman (2007), which emphasise systematic exposure, meaningful practice, and active learner engagement. Each instructional unit included 12 target vocabulary items, carefully selected to align with learners' proficiency levels and curriculum objectives. Throughout the lessons, students encountered the same vocabulary items multiple times through a variety of digital or non-digital game-based activities, depending on their assigned group, thereby ensuring repeated retrieval across diverse contexts. A typical lesson follows a structured sequence, beginning with the introduction of target vocabulary through brief explanations and contextualised examples. This was followed by guided practice, during which learners engaged with the vocabulary through games. Immediate feedback and peer discussion were then incorporated to help learners identify errors and refine their understanding. Finally, consolidation activities were implemented to reinforce form–meaning connections through repeated and meaningful gameplay, including collaborative tasks and reflective discussions to deepen learners' comprehension of the material.

G. Data Analysis

Descriptive and inferential statistical analyses were conducted to examine the effects of digital and non-digital game-based instruction on Thai EFL learners' vocabulary knowledge (RQ1) and to provide a comprehensive evaluation of the intervention. To determine whether significant vocabulary gains occurred within each group, paired-samples t-tests were used to compare pre-test and post-test mean scores. In addition, an independent-samples t-test was conducted to compare post-test scores between the digital game-based learning (DGBL) group and the non-digital game-based learning (NDGBL) group, assessing the extent to which the mode of instruction influenced vocabulary development. Furthermore, a repeated-measures ANOVA was employed to examine differences across test types (i.e., receptive recognition, receptive recall, productive recognition, and productive recall) and to analyse changes in vocabulary knowledge across time for both groups. Post hoc analyses were conducted to identify specific differences between test conditions and to provide a more detailed interpretation of the learning outcomes.

Regarding students' perceptions of the two instructional approaches (RQ2), descriptive statistics, including means, standard deviations, and percentages, were calculated from responses to a five-point Likert-scale questionnaire. This analysis revealed students' attitudes, levels of engagement, and perceived benefits of using digital and non-digital games as vocabulary-learning tools, thereby highlighting the motivational and interactive nature of the instructional approaches.

IV. Results

A. The Effects of Digital Games and Non-Digital Games on Vocabulary Knowledge

(a). Receptive Vocabulary Performance Results

Table 1 presents performance scores on the receptive recognition and receptive recall tests at two time points. The results indicated that post-test scores were higher than pre-test scores in both the digital and non-digital groups. Specifically, for receptive recognition, the digital group's mean rose from 12.42 (S.D. = 3.68) on the pre-test to 16.28 (S.D. = 3.72) on the post-test. Similarly, the non-digital group improved, with mean scores rising from 12.46 (S.D. = 3.41) to 16.08 (S.D. = 3.42). Paired-samples *t*-tests revealed statistically significant within-group differences for both groups (digital: $t = 4.28$, $p < .001$; non-digital: $t = 10.28$, $p < .001$), indicating that both instructional approaches significantly enhanced learners' receptive recognition of vocabulary. A similar pattern was observed in the receptive recall test. The digital group's mean score increased from 10.33 (S.D. = 5.18) to 14.75 (S.D. = 4.01), while the non-digital group improved from 9.77 (S.D. = 3.41) to 13.08 (S.D. = 4.14). These improvements were also statistically significant (digital: $t = 8.32$, $p < .001$; non-digital: $t = 6.75$, $p < .001$). Overall, the findings suggest that both digital and non-digital game-based learning improved learners' receptive vocabulary, including recognition and recall of vocabulary's form-meaning links.

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TABLE 1
PARTICIPANTS' SCORES ON THE RECEPTIVE VOCABULARY TEST WITHIN GROUPS

Tests	Groups	Pre-test Mean (%)	S.D.	Post-test Mean (%)	S.D.	*t* (within)	*p* (within)
Receptive recognition	Digital	12.42 (62.08%)	3.68	16.28 (81.39%)	3.72	4.28	0.001*
	Non-digital	12.46 (62.31%)	3.41	16.08 (80.38)	3.42	10.28	0.001*
Receptive recall	Digital	10.33 (51.67%)	5.18	14.75 (73.75%)	4.01	8.32	0.001*
	Non-digital	9.77 (48.84%)	3.41	13.08 (65.38%)	4.14	6.75	0.001*

***Note:** the total score = 20; $p < 0.001$.

Table 2 presents participants' scores on the receptive vocabulary tests for the experimental and control groups. Independent-samples *t*-tests indicated no statistically significant differences between the digital and non-digital groups at both pre-test and post-test for receptive recognition and recall ($p > .05$). These findings indicate that although both instructional methods were associated with gains in receptive vocabulary knowledge, neither pedagogical mode outperformed the other, suggesting that the observed improvements were attributable to the shared game-based instructional design rather than the mode of delivery.

TABLE 2
PARTICIPANTS' SCORES ON THE RECEPTIVE VOCABULARY TEST BETWEEN GROUPS

Tests	Time	Digital group	S.D.	Non-digital group	S.D.	*t* (between)	*p* (between)
Receptive recognition	Pre-test	12.42 (62.08%)	3.68	12.46 (62.31%)	3.41	-0.05	0.96
	Post-test	16.28 (81.39%)	3.72	16.08 (80.38)	3.42	0.24	0.80
Receptive recall	Pre-test	10.33 (51.67%)	5.18	9.77 (48.84%)	4.01	0.52	0.61
	Post-test	14.75 (73.75%)	3.41	13.08 (65.38%)	4.14	1.77	0.80

***Note:** the total score = 20; $p > .05$.

(b). Productive Vocabulary Performance Results

Table 3 presents the results of the productive recognition and productive recall tests. For productive recognition, the digital group's mean score increased significantly from 2.17 (S.D. = 2.24) on the pre-test to 4.06 (S.D. = 4.16) on the post-test ($t = 4.22$; $p < .001$). Similarly, the non-digital group showed significant improvement, with mean scores rising from 1.90 (S.D. = 2.02) to 3.56 (S.D. = 3.12). The paired-samples *t*-test revealed statistically significant differences ($t = 5.74$, $p < .001$). These findings suggest that both instructional techniques significantly enhanced learners' recognition of productive vocabulary.

TABLE 3
PARTICIPANTS' SCORES ON THE PRODUCTIVE VOCABULARY TEST WITHIN GROUPS

Tests	Groups	Pre-test Mean (%)	S.D.	Post-test Mean (%)	S.D.	*t* (within)	*p* (within)
Productive recognition	Digital	2.17 (14.44%)	2.24	4.06 (27.04%)	4.16	4.22	0.001*
	Non-digital	1.90 (12.65%)	2.02	3.56 (23.76%)	3.12	5.74	0.001*
Productive recall	Digital	2.03 (13.52%)	2.60	3.31 (22.04%)	3.72	2.99	0.05
	Non-digital	1.82 (12.13%)	1.90	3.26 (21.71%)	3.17	3.45	0.001*

***Note:** the total score = 20; $p < 0.001$.

Table 4 shows a similar trend in productive recall across groups. The digital group's mean score increased by 8.52% on the productive recall test (S.D. = 2.60 for the pre-test and S.D. = 3.72 for the post-test), while the non-digital group improved by 9.58%, rising from 1.82 (S.D. = 1.90) to 3.26 (S.D. = 3.17). The improvement in the non-digital group was statistically significant ($t = 3.45$, $p < .001$), whereas the digital group showed a marginally significant difference ($t = 2.99$, $p = .05$). Together, these findings indicate that both digital and non-digital game-based learning contributed to improvements in learners' productive vocabulary knowledge, although the effect was more consistently significant in the non-digital group for productive recall.

Independent-samples t-tests were also conducted to assess performance differences between the digital and non-digital groups on vocabulary tests. The results indicated no statistically significant differences, suggesting that both instructional techniques produced comparable improvements in learners' productive vocabulary knowledge, with no clear advantage for either modality.

TABLE 4
PARTICIPANTS' SCORES ON THE PRODUCTIVE VOCABULARY TEST BETWEEN GROUPS

Tests	Time	Digital group	S.D.	Non-digital group	S.D.	*t* (between)	*p* (between)
Productive recognition	Pre-test	2.17 (14.44%)	2.24	1.90 (12.65%)	2.02	0.54	0.59
	Post-test	4.06 (27.04%)	4.16	3.56 (23.76%)	3.12	0.58	0.56
Productive recall	Pre-test	2.03 (13.52%)	2.60	1.82 (12.13%)	1.90	0.39	0.69
	Post-test	3.31 (22.04%)	3.72	3.26 (21.71%)	3.17	0.06	0.95

***Note:** the total score = 20; $p > .05$.

(c). Differences Between the Four Types of Tests Among Pre-Tests and Post-Tests

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To assess varying levels of vocabulary knowledge, repeated-measures ANOVA analyses were also conducted. As presented in Table 5 and Figure 1, the results revealed statistically significant differences among the four test types at both time points for both instructional groups. In the digital games group, significant test-type effects were observed at the pretest, $F(3, 257.78) = 88.19$, $p < .001$, $\eta^2 = .72$, and again at the posttest, $F(3, 205.70) = 166.51$, $p < .001$, $\eta^2 = .83$. Similarly, the non-digital games group demonstrated highly significant differences among test types at the pretest, $F(3, 98.98) = 256.86$, $p < .001$, $\eta^2 = .87$, and at the posttest, $F(3, 128.17) = 266.72$, $p < .001$, $\eta^2 = .88$. The large effect sizes (η^2 between 0.72 and 0.88) across vocabulary tests in both groups and at different time points indicate that test type exerted a strong and consistent influence on vocabulary performance, regardless of instructional condition. Overall, the findings reveal a performance hierarchy across the four vocabulary test types, with receptive recognition producing the highest scores, followed by receptive recall, productive recognition, and productive recall.

TABLE 5
DIFFERENCES BETWEEN THE FOUR TYPES OF TESTS AMONG PRE-TESTS AND POST-TESTS

Groups	Test Types	Pre-test			Post-test		
		Mean (%)	*F*	η^2	Mean (%)	*F*	η^2
Digital games (*n*=36)	Receptive Recognition	12.42 (62.08)	88.19	0.72	16.28 (81.39)	166.51	0.83
	Receptive Recall	10.33 (51.67)			14.75 (73.75)		
	Productive Recognition	2.17 (14.44)			4.06 (27.04)		
	Productive Recall	2.03 (13.52)			3.31 (22.04)		
Non-digital games (*n*=39)	Receptive Recognition	12.46 (62.31)	256.86	0.87	16.08 (80.38)	266.72	0.88
	Receptive Recall	9.77 (48.84)			13.08 (65.38)		
	Productive Recognition	1.90 (12.65)			3.56 (23.76)		
	Productive Recall	1.82 (12.13)			3.26 (21.71)		

***Note:** the total score = 20.

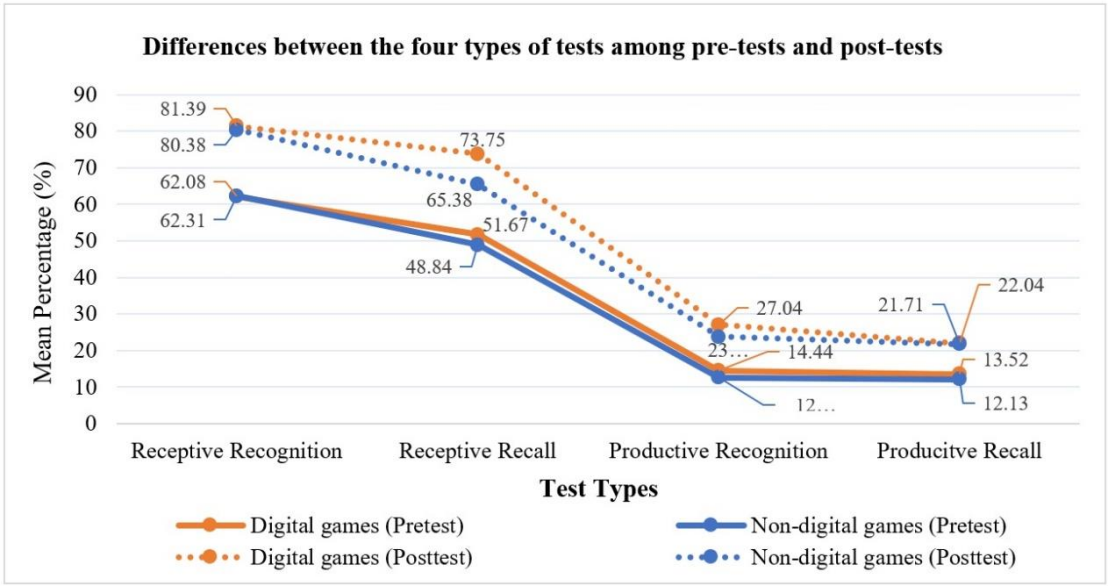


Figure 1. Differences Between the Four Types of Tests Among Pre-Test and Post-Tests

B. The Effects of Digital Games and Non-Digital Games on Students' Perceptions of Vocabulary Learning

The results, summarised in Table 6, highlight students' positive perceptions of digital games. The overall mean score across all questionnaire items was 4.40 (88%), with a standard deviation of 0.77. These findings indicate that Thai secondary school participants have a high level of positive agreement with learning vocabulary through digital games. High ratings across all items reflect strong engagement, enjoyment, and active participation. Students reported feeling pleased ($\bar{x} = 4.78$) and relaxed ($\bar{x} = 4.56$), and demonstrated effort, attention, and motivation in learning new words. Overall, these findings suggest that digital game-based learning creates an engaging and supportive environment that encourages active involvement and sustained interest in vocabulary learning.

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TABLE 6
STUDENTS' PERCEPTIONS OF DIGITAL GAMES

No.	Items	$\bar{x}$	S.D.	%	Meaning
1	I am actively involved in digital game-based vocabulary activities.	4.42	0.73	88%	Very high
2	I try hard to finish the vocabulary tasks in digital games.	4.53	0.65	91%	Very high
3	I pay close attention during digital game-based lessons.	4.44	0.69	89%	Very high
4	I feel happy when I learn vocabulary through digital games.	4.78	0.42	96%	Very high
5	I feel excited to learn new words through digital games.	4.36	0.89	87%	Very high
6	I feel more relaxed while using digital games to learn vocabulary.	4.56	0.65	91%	Very high
7	I think carefully about the vocabulary used in digital games.	4.22	0.83	84%	Very high
8	I try to understand the meaning of each new word in the game.	4.47	0.84	89%	Very high
9	I focus on learning vocabulary while playing digital games.	4.36	0.79	87%	Very high
10	I ask questions or share my ideas during digital game lessons.	4.14	0.96	83%	Very high
11	I give suggestions to improve the digital learning games.	4.05	1.04	81%	Very high
12	I show initiative to learn new words during or after the games.	4.48	0.77	90%	Very high
Total		**4.40**	**0.77**	**88%**	**Very high**

The analysis of the questionnaire data also indicated participants' high level of positive perception of learning vocabulary through non-digital games. The results showed an overall mean score of 4.37 ($\bar{x}$ = 87%; S.D. = 0.75). High ratings across all items reflect strong engagement, enjoyment, and active participation. Students reported feeling relaxed ($\bar{x}$ = 4.51) and demonstrated a strong effort to understand word meanings ($\bar{x}$ = 4.62), while also showing motivation and focus in learning new vocabulary. Overall, these findings suggest that non-digital game-based learning fosters an engaging, supportive environment that encourages active involvement and sustained interest in vocabulary learning.

TABLE 7
STUDENTS' PERCEPTIONS OF NON-DIGITAL GAMES

No.	Items	$\bar{x}$	S.D.	%	Meaning
1	I am actively involved in non-digital game-based vocabulary activities.	4.33	0.70	87%	Very high
2	I try hard to finish the vocabulary tasks in non-digital games.	4.35	0.71	87%	Very high
3	I pay close attention during non-digital game-based lessons.	4.30	0.73	86%	Very high
4	I feel happy when I learn vocabulary through non-digital games.	4.46	0.75	89%	Very high
5	I feel excited to learn new words through non-digital games.	4.46	0.71	89%	Very high
6	I feel more relaxed while using non-digital games to learn vocabulary.	4.51	0.68	90%	Very high
7	I think carefully about the vocabulary used in non-digital games.	4.26	0.91	85%	Very high
8	I try to understand the meaning of each new word in the game.	4.62	0.59	92%	Very high
9	I focus on learning vocabulary while playing non-digital games.	4.46	0.68	89%	Very high
10	I ask questions or share my ideas during non-digital game lessons.	4.08	0.89	82%	Very high
11	I give suggestions to improve the non-digital games for learning.	4.00	1.00	80%	Very high
12	I show initiative to learn new words during or after the games.	4.62	0.63	92%	Very high
Total		**4.37**	**0.75**	**87%**	**Very high**

V. DISCUSSION

A. Effects of Digital and Non-Digital Game-Based Instruction on Vocabulary Learning

The results reported in this study indicate that both digital and non-digital game-based instructional techniques can enhance receptive and productive vocabulary acquisition among Thai secondary school learners over time. The consistent gains observed across phases suggest that these instructional modes are effective for teaching new vocabulary and may also aid the retention of form-meaning mappings. Similar results have been reported in our previous studies, which indicated that game-based learning is effective for EFL learners (Nation, 2022; Teemueangsai et al., 2025; Webb & Nation, 2017) and that retrieval practice promotes vocabulary acquisition through repeated exposure to words.

Theoretically, these findings can be explained by Paivio's (1986, 2006) dual coding theory, which suggests that we learn more easily when information is processed through both our verbal and nonverbal systems. In the current study, both digital and non-digital games may have elicited these processes. Digital games usually integrate written input, auditory feedback, and dynamic visual elements, whereas non-digital games typically combine verbal explanations, peer discussions, and visual or physical materials. This multimodal engagement may have promoted more robust form-meaning associations for receptive vocabulary knowledge.

One important finding is that receptive vocabulary knowledge, particularly recognition, outperformed recall (productive), which remained relatively lower. This pattern aligns with established models of vocabulary acquisition (Nation, 2022; Schmitt, 2010), which theorise that vocabulary development progresses along a continuum, from receptive access to productive control. This distinction may be further explained by dual coding theory, in which visual and contextual cues often aid recognition, whereas productive recall requires learners to retrieve lexical forms independently, placing a greater burden on memory and processing.

Additionally, the findings could be understood in the context of Sweller's (1994) cognitive load theory. Because digital games feature more structured interfaces, immediate feedback, and guided task sequences, the cognitive load associated with extraneous processing may have been reduced, allowing learners to reallocate cognitive resources from extraneous

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processing to lexical processing. In contrast, digital games may have discouraged deeper semantic processing through faster-paced interaction, peer negotiation, and the ubiquity of verbal rehearsal. Collectively, these complementary processes suggest that both modes of instruction might support vocabulary learning through divergent yet perhaps comparably potent cognitive processes.

Although inferential analysis found no statistically significant differences between the two groups, a few descriptive trends appear pedagogically important. Across the reception domain, digital users performed slightly better on recall-based tasks, suggesting a modest boost in controlled retrieval and short-term consolidation, potentially due to user interference from immediate feedback and repetition cycles. By contrast, the group that did not use digital materials performed better on recognition tasks, indicating that social interaction and embodied engagement may strengthen visual-verbal associations. These nuanced results also align with previous studies on the differential impact of instructional conditions on distinct aspects of vocabulary knowledge (Laufer & Goldstein, 2004; Stæhr, 2008).

Crucially, both formats appear to have offered more opportunities for retrieval practice, an approach known for its role in vocabulary learning, according to Webb and Nation (2017). Learners engaged with lexical items through repeated exposure, decision-making, and information retrieval. Thus, such repeated retrieval may account for some of the sustained gains and, by extension, retention. In addition, the game-based settings may have fostered low-anxiety, motivating situations that would facilitate sustained involvement and risk-taking, conditions known to promote growth in applied vocabulary development.

In a Thai EFL context, these results appear to support previous research suggesting that learners are likely to have stronger receptive than productive vocabulary knowledge (Nontasee & Sukying, 2023; Sukying, 2025). However, the current study extends this work by testing a different hypothesis about productive vocabulary knowledge: that teaching (when activities involve interaction, repetition, and communicative engagement) may have a larger effect than previously thought. This provides preliminary evidence that a game-based approach may offer a strategy for addressing long-standing issues in fostering learners' active vocabulary use.

B. Learners' Perceptions of Digital and Non-Digital Game-Based Vocabulary Learning

Results on learners' perceptions indicated that both digital and non-digital game-based instruction were perceived as enjoyable and effective for vocabulary learning. These positive impressions appear to align with previous research, which shows that game-based learning environments can boost learner motivation, engagement, and attitudes towards language learning (Teemueangsai et al., 2025).

Constructivist learning theory, as reflected in these results, is evident in Vygotsky's (1978) work, which stressed the importance of social interaction and active participation in learning. Specifically, non-digital games might have supported collaborative learning, peer discussion, and negotiation of meaning, all of which are conducive to co-constructing knowledge in meaningful contexts. This interaction likely fostered positive attitudes and engagement among students.

Concurrently, digital games appeared to offer interactive, visually engaging experiences that may have fostered motivation and sustained learners' engagement over time. Features such as instant feedback, game mechanics, and multimedia input may have led learners to view computerised games as rewarding and an easy way to learn vocabulary. This aligns with studies showing that a digital environment may promote cognitive and affective engagement in learning, thereby enhancing L2 acquisition.

What was intriguing, however, was that learners did not see digital and non-digital games as competing methods, but rather as complementary instructional materials. On the one hand, digital games were associated with convenience, speed, and an orderly way to obtain feedback, whereas non-digital ones led to interaction, cooperation, and more intricate discussion. This finding also corroborates the recent trend towards blended or hybrid instruction in EFL settings, suggesting that learners may benefit more from a balanced combination of modalities.

VI. Conclusion

The findings of this study indicated that both digital and non-digital game-based instruction can improve EFL learners' vocabulary learning and long-term retention, particularly by reinforcing the form-meaning connection through active involvement. Both receptive and productive vocabulary knowledge improved significantly, with gains persisting in subsequent assessments. Importantly, the statistically non-significant difference between the two modes suggests that pedagogical design, rather than the technological medium alone, may be a more relevant driver of learning outcomes. Both pedagogical modes foster positive perceptions among learners, helping to create motivating and engaging environments.

Pedagogically, the arguments emphasise the need to design tasks that are goal-specific, promote retrieval practice, and foster interaction to support meaningful language use. Digital and non-digital games appear to serve as complementary tools, suggesting that a blended approach might yield the greatest engagement and learning. Aligning task difficulty and pacing with learners' skill levels may further enhance effectiveness. On a methodological level, the study showcases the potential of an integrated mixed-methods approach to capture learning outcomes and learner experiences holistically. However, a few limitations need to be recognised. Generalisability is limited using a single, context-based sample. Furthermore, concentrating solely on the form-meaning connection fails to adequately address the many facets of vocabulary knowledge, and the limited duration may not suffice for long-term development. More studies with

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heterogeneous populations, delivered over a longer period and using broader measures of lexical knowledge (e.g., productive collocations or contextual meaning), are needed in future research. Future research may also investigate other language competencies and compare game-based instruction with non-game-based instructional methods.

Together, these findings add to the growing evidence of the effectiveness of game-based instruction in facilitating receptive and productive vocabulary development and tentatively support the use of combined digital and non-digital strategies in EFL classrooms.

ACKNOWLEDGEMENTS

This research project was financially supported by Mahasarakham University.

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