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How do text type, prior vocabulary knowledge, and working memory capacity affect second language incidental vocabulary learning through reading?

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Abstract

Incidental vocabulary learning through reading may be influenced by a range of learner-internal as well as learner-external factors. This study, specifically, examined the potential impacts of three factors: text type, prior L2 vocabulary knowledge, and working memory capacity. Forty-six 1st grade high school students in Korea completed a battery of tests: (a) the Vocabulary Levels Test and (b) a reading span task as measures of prior vocabulary knowledge and working memory capacity, respectively. All the participants read two texts (one narrative and one expository) containing pseudowords and completed two reading comprehension tasks. Immediately after reading and again two days later, two measures of vocabulary gains were administered: (a) a form recognition test and (b) a meaning recognition test. The results revealed that the narrative text was more effective in aiding L2 vocabulary acquisition in the long term than the expository text. Both prior vocabulary knowledge and working memory capacity played facilitative roles in the lexical inferencing process and

retention, but working memory capacity had much stronger effects throughout all the posttests. A significant interaction between text type and working memory capacity was also observed, suggesting that the text type effective for incidental learning differed according to learners' individual differences in language learning aptitude. Some implications for designing the classes that implement incidental vocabulary learning are discussed.

Keywords: incidental vocabulary learning; text type; prior vocabulary knowledge; working memory capacity

1. Introduction

Within the research domain of instructed second language acquisition (ISLA), incidental learning, or the acquisition of knowledge without intention while engaged in another activity, is understood as an important aspect of second language (L2) learning (Ortega, 2009). Specifically, for L2 vocabulary acquisition, it is expected that providing ample opportunities for learners to get exposed to the real use of words through reading is beneficial for building up L2 vocabulary knowledge (Pellicer-Sánchez & Schmitt, 2010; Teng, 2020; Uchihara et al., 2019). At the same time, many factors appear to make the rate and outcome of incidental L2 vocabulary learning inconsistent. These factors are twofold: learner-internal factors, such as motivation, attitude, and aptitude, and learner-external factors, such as the quantity of input and cultural contexts (Chen, 2021; Jin & Webb, 2020; Li & DeKeyser, 2021; Malone, 2018; Webb, 2007).

Indeed, incidental vocabulary learning does not occur automatically simply because the learner is exposed to the target vocabulary. Of various factors, this study took an interest in the roles of text type in mediating the learning effects. The content, structure, and vocabulary of a text can all vary depending on text type, and this affects the way learners accept and process different texts and, in consequence, causes differential learning outcomes (Gardner, 2004; Mar et al., 2021). However, much of the previous research on incidental learning used either one type of text (Feng & Webb, 2020; Hatami & Tavakoli, 2012; Pellicer-Sánchez & Schmitt, 2010; Teng, 2024; Waring & Takaki, 2003), without comparing multiple types of reading texts and accordingly, further research appears necessary to better understand the relationship between text type and incidental vocabulary learning. A few studies have experimented with narrative and expository texts for L2 vocabulary learning, but the results regarding the effectiveness of different text types remain inconsistent. This inconsistency is likely due to learner characteristics that have not been fully considered (Nguyen, 2023; Shokouhi & Maniati, 2009).

Many scholars assert that the inconsistency in the findings of L2 incidental vocabulary gains through reading is attributed to a lack of focus on learner characteristics when designing learning environments (Elgort et al., 2015; Teng, 2022; Pulido, 2003, 2007a). A learner-internal factor well-known to contribute to incidental vocabulary learning through reading is prior vocabulary knowledge. It might be that learners who have rich prior vocabulary knowledge not only have a high level of understanding the text content but also effectively process unknown words within context (Feng & Webb, 2020; Pulido, 2003; Swanborn & de Glopper, 1999; Webb & Chang, 2015).

Another significant cognitive factor believed to predict success in vocabulary learning is working memory capacity (WMC). Working memory (WM) is a system with limited capacity that temporarily stores and manipulates information, supporting human thought processes and cognitive tasks (Conway et al., 2005). It is presumed to play a crucial role in various cognitive functions, including language comprehension (Baddeley, 2003). Many empirical studies have shown that WMC affects both the quantity and quality of text processing performance in both first language (L1) (Daneman & Merikle, 1996) and L2 contexts (Linck et al., 2014). Concerning vocabulary development, in particular, Daneman (1988) and Hulstijn (2001) have emphasized that WMC plays a vital role in processing new words. A handful of studies (e.g., Alptekin & Erçetin, 2011; Harrington & Sawyer, 1992; Lee, 2014; Leeser, 2007; Martin & Ellis, 2012) have revealed a positive relationship between WMC and reading comprehension in intentional vocabulary learning; however, there is less research on the effects of WMC on incidental vocabulary learning through reading (de Leeuw et al., 2014; Malone, 2018; Teng, 2024; Varol & Erçetin, 2016). Additionally, simple span tasks, such as the backward digit span, which have been widely used in the literature, may not fully capture the complexities of WMC in language learning, further contributing to the uncertainty regarding its effects on incidental vocabulary learning (e.g., de Leeuw et al., 2014; Varol & Erçetin, 2016).

Overall, given the research gap in the current literature and the variability of empirical research findings to date, the present study sought to investigate three specific factors that affect incidental vocabulary learning through reading. These factors include the type of text used in the learning process, learners' prior knowledge of L2 vocabulary, and their WMC. It was anticipated that the results of this study would enhance our comprehension of the critical aspects to consider when designing incidental vocabulary learning in educational settings.

2. Literature review

Learning an L2 may proceed in different ways: either intentionally or incidentally (Hulstijn, 2006). Over the last decade, many ISLA researchers have explored the

feasibility of incidental vocabulary learning. They have addressed this question most actively in the field of vocabulary acquisition (e.g., Bruton, 2007; Dang et al., 2023; de Leeuw et al., 2014; Elgort & Warren, 2014; Huang et al., 2012; Hulstijn, 2001; Nie et al., 2022; Pellicer-Sánchez & Schmitt, 2010; Pulido, 2003, 2007a, 2007b; Swanborn & de Glopper, 1999; Teng, 2020; Varol & Erçetin, 2016; Webb & Chang, 2015, 2022). Considering the vast amount of vocabulary items in a language, there is a limit to learning them only through explicit instruction. Learners often face new words and have to build their meanings from context incidentally, and that process is where a better understanding is needed for more effective vocabulary learning and retention. While incidental vocabulary learning is influenced by various factors, the type of text plays a notable role. Understanding the distinctions between narrative and expository texts – which are commonly and extensively used in educational settings – and how they shape the learning process is key to enhancing vocabulary acquisition in L2 learners. This study also aims to investigate how learners' prior vocabulary knowledge and WMC, as measured by a complex span task, interact with text type to affect the effectiveness of incidental vocabulary learning.

2.1. Text type

Research done on reading has typically divided reading texts into two types, narrative and expository, based on their purpose and structure (Härtig et al., 2022; Yanagisawa et al., 2020). Within a sequence of events, narrative texts serve the purpose of illustrating the goals of the protagonist, the conflicts and obstacles that the protagonist faces, and a range of emotions that emerge from the process of solving them. Narrative texts depict that all of these components together construct "a microworld," and they do not require learners to have additional cognitive abilities to understand this world (Graesser et al., 2003). This is because it is likely that learners already have routine experiences related to the events (Clinton et al., 2020; Graesser et al., 2003). Moreover, the gradual development of the story and the simple sentence structure may reduce the burden on learners' working memory, causing facilitation not only in the understanding of the text but also in learning the language (Best et al., 2008; Dymock, 2007; cf. Hiebert & Cervetti, 2012). Expository texts are distinct from narrative texts in terms of structure, content, and linguistic complexity (Clinton et al., 2020; Härtig et al., 2022). They are characterized by specialized content that learners cannot easily experience, necessitating specific prior knowledge (Best et al., 2008; Clinton et al., 2020). In many cases, they use longer and more technical terminology with rhetorically complex sentences (Hiebert & Cerbetti, 2012; McNamara et al., 2012). Accordingly, when reading an expository text in L2,

learners are often required to have high information processing capacity (Best et al., 2008; Graesser et al., 2003). At the same time, some researchers (McNamara, 2001; McNamara et al., 2012) have shown that language learning through expository texts can be improved as long as frequent repetition of terminology and use of sentence-connecting devices increase cohesion between sentences, compensating for the unfamiliarity of content distributed in the text.

Despite the distinct characteristics of both text types, most studies on L2 incidental vocabulary learning have utilized only one type of text (e.g., Huang et al., 2012; Pellicer-Sánchez & Schmitt, 2010; Pulido, 2003, 2007a; Teng, 2020). Few studies have explored the relationship between text type and incidental vocabulary learning, but the results suggest that a consensus has not yet been reached on which text type is most effective for advancing L2 vocabulary development (e.g., Nguyen, 2023; Shokouhi & Maniati, 2009; Webb et al., 2023). Gardner's (2004) analysis found that narrative texts use more common words, while expository texts have a higher proportion of specialized vocabulary, which may affect how children learn new words. He concluded that narrative texts are more conducive to incidental vocabulary learning. However, the applicability of these results to L2 learners remains unclear, as Gardner's (2004) study focused on children learning their L1. Shokouhi and Maniati (2009) studied the impact of text type on incidental vocabulary learning with 40 Iranian English as a foreign language (EFL) college students. The group reading expository texts gained more new words, likely due to their focus on unfamiliar language, while the narrative group benefited from the broader understanding afforded by the overall text structure. Nguyen (2023) studied the effect of text type on incidental vocabulary learning with 109 Vietnamese L2 learners. Expository and twin texts led to greater vocabulary gains, with Nguyen (2023) highlighting that twin texts combine elements that help maintain coherence, encourage inferences, and focus attention on new words, thereby enhancing vocabulary acquisition. Webb et al. (2023) conducted a meta-analysis on 24 primary studies that explored various factors affecting L2 incidental vocabulary learning. Their findings revealed that text type is a significant moderator, with learners acquiring more vocabulary from narrative texts compared to expository texts. While these results align with Gardner (2004), it is important to note that the primary studies included in the meta-analysis each focused on only one type of text, either narrative or expository, so no research directly comparing both text types was included.

2.2. Prior vocabulary knowledge

Many studies have examined the effects of prior vocabulary knowledge, as a type of learner-internal variable, not only on reading comprehension but also on L2

vocabulary learning through reading (de Leeuw et al., 2014; Feng & Webb, 2020; Hatami & Tavakoli, 2012; Pulido, 2003, 2007a, 2007b; Swanborn & de Glopper, 1999; Teng, 2024; Webb & Chang, 2015). Hatami and Tavakoli (2012) investigated the relationship between vocabulary breadth and depth, and lexical inferencing ability. Fifty university seniors were initially assessed for their vocabulary knowledge and then asked to infer the meaning of target words in a lexical inferencing task. The study found that both vocabulary breadth (number of words known) and depth (knowledge about words) were important for successful inference.

Concerning the roles of prior vocabulary knowledge in text processing and incidental vocabulary learning, how to measure learners' vocabulary knowledge remains an important issue. The Vocabulary Levels Test (VLT) (Nation, 1983), as a measure for general vocabulary knowledge at five frequency levels of English word families (i.e., 2,000, 3,000, 5,000, 10,000, and academic vocabulary), has been extensively used in the literature (Hatami & Tavakoli, 2012; Paribakht, 2005; Read, 2000; Schmitt et al., 2001). When it comes to more recent studies, Feng and Webb (2020), Teng (2024), as well as Webb and Chang (2015) utilized the VLT, albeit in slightly different versions, to measure learners' vocabulary knowledge while investigating their incidental vocabulary development.

In Webb and Chang (2015), 60 Taiwanese high school students participated in a 37-week reading program, where they read 20 graded readers consisting of a mix of narrative and expository texts. Participants were divided into high, intermediate, and low groups based on their pretest scores measuring target vocabulary knowledge. Demonstrating a positive correlation with posttests held one week after finishing the last graded reader and again three months later, learners with higher levels of prior vocabulary knowledge showed better retention of vocabulary. Feng and Webb (2020) examined how different ways of processing a documentary (reading, listening, watching) affect vocabulary learning with 76 university EFL students. While there were no significant differences in vocabulary gains or retention across the three modes, participants with larger initial vocabularies demonstrated superior incidental vocabulary learning and retention within both the reading and viewing groups. Teng's (2024) study involved 150 university students and compared four experimental conditions (i.e., listening, reading, reading-while-listening, and viewing captioned videos) with a control group. Prior vocabulary knowledge served as a strong moderator, particularly influencing effective vocabulary learning in reading and reading-while-listening conditions. In the reading condition, where learners read a script of a documentary, prior vocabulary knowledge had a significant impact on both form and meaning recognition for the immediate posttest, but did not have a significant effect on vocabulary retention for the delayed posttest.

As can be seen from the above, research has demonstrated that prior vocabulary knowledge plays a significant role in vocabulary gains, regardless of the

input mode – whether reading, listening, or viewing. This study explores whether learners with extensive prior vocabulary knowledge outperform those with limited knowledge in vocabulary learning through different text types. It also examines the interaction between prior vocabulary knowledge and text type (narrative vs. expository) in incidental vocabulary learning and retention.

2.3. Working memory capacity (WMC)

Baddeley and Hitch (1974) describe working memory (WM) as a system that temporarily manipulates and stores a small amount of information when performing cognitive tasks, such as language comprehension and processing. A major component of WM is the central executive, which plays its role in distributing attention by processing and manipulating information. The central executive subsystem includes the phonological loop that temporarily stores meaningful linguistic sounds and the visuospatial sketchpad that stores visual images. The episodic buffer, which was added in 2000, links WM and long-term memory (Baddeley, 2000).

In the early stages of L2 learning, WMC is effective in preventing the interference of the L1, and this allows extra resources to be allocated to L2 processing (Michael & Gollan, 2005). Several studies have found a positive correlation between WMC and L2 proficiency (Linck et al., 2014; Revész, 2012), especially in reading research (Alptekin & Erçetin, 2011; Harrington & Sawyer, 1992; Leeser, 2007). For example, Harrington and Sawyer (1992) observed a meaningful relationship between reading skills and WMC, measured by a reading span task (Daneman & Carpenter, 1980). The reading span task (RST) that was used is a popular complex task designed to determine the capacity of the central executive in regard to both processing and storage. Specifically, the plausibility judgment task within the RST tests the processing component, and the recall task of final words in each sentence tests the storage component.

The empirical findings concerning the effects of WM on incidental vocabulary learning have been mixed, depending on the types of input and measures of WMC. De Leeuw et al. (2014) examined how 45 Dutch fifth-graders learn new words incidentally while reading and found that WM, as measured by a backward digit span task, did not significantly influence incidental word learning. However, an interaction was noted between task type and WM, where children with higher WMC performed better on inference questions. Regarding the effect of WM on word learning, de Leeuw et al. (2014) acknowledged that "the digit span task may not fully capture the complexities of WM involved in language learning" (p. 284). Similarly, Varol and Erçetin (2016) examined the effects of gloss type and found that higher WMC measured through a backward digit span

led to better reading comprehension among 90 Turkish university students but did not significantly impact vocabulary learning. These studies suggest that simple span tasks like the backward digit span may not fully capture the complexities of WM involved in language learning.

Several researchers have employed various span tasks to assess the complex facets of WMC (Malone, 2018; Montero Perez, 2020; Revész, 2012; Teng, 2024). These span tasks necessitate the simultaneous recall of items while engaging in unrelated activities, such as solving math problems or comprehending text, making them "more effective predictors of higher-order cognitive abilities than simple span tasks" (Unsworth & Engle, 2006, p. 69). For instance, Malone (2018) investigated the impact of exposure frequency, aural enhancement (listening while reading), and WM on incidental vocabulary learning among 80 intermediate English language learners from two US universities. The study divided participants into four groups which engaged in reading tasks with target words presented either two or four times, with or without audio support. WM was assessed through three tasks: a nonword span task, an operation span task, and a Shapebuilder task. Results showed a strong correlation between WM and form recognition, especially in groups with aural enhancement, suggesting that learners with higher WMC benefited more from the cognitive load of listening while reading. Similar results were reported by Teng (2024), who used the RST to measure WM in university students, demonstrating that the ability to simultaneously store and process information is crucial for effective incidental vocabulary learning across various input modes. Given the wide range of design features from study to study and the inconsistent findings, it appears necessary to continue the investigation into the roles of WMC in incidental vocabulary learning.

To sum up, the literature on incidental vocabulary learning through reading highlights the distinct advantages of narrative and expository texts, the significant role of prior vocabulary knowledge, and the influence of WMC. However, findings on which text type is more effective remain inconclusive, and there is a need to investigate how these text types interact with individual learner variables. While prior vocabulary knowledge consistently aids vocabulary learning, the impact of WMC is mixed, indicating the need for more nuanced measures of WMC in language learning contexts. This research gap points to the necessity of examining the combined effects of text type, prior vocabulary knowledge, and WMC on incidental vocabulary acquisition. The study therefore aimed to answer the following research question:

> How do text type, prior vocabulary knowledge, WMC, and their interactions affect L2 incidental vocabulary acquisition and retention through reading?

3. Method

3.1. Participants

This study was conducted with 53 first-year students (equal to 10th grade) from two classes at a general private high school in Daegu, South Korea. This school transitioned from a commercial high school to a general high school less than seven years before the study and was composed entirely of students who apply voluntarily. The students came from a diverse range of middle school academic backgrounds, with overall grades ranging from the top 5% to the bottom 20% within Daegu area. All participants were native Korean speakers and EFL students who had received formal English education in school for seven years, starting from the third grade. The two classes were participating in supplementary winter break classes at the time of the study. Based on the English achievement scores in the second semester of their first year, one class (24 students) had an average score of 80.8, while the other class (29 students) had an average score of 68.3 on a 100-point scale. Seven students were excluded during the data-collecting process because they did not complete both form and meaning recognition tests administered during the delayed posttest. In order to examine the effects of prior vocabulary knowledge and WMC more clearly, nine of the remaining 46 students whose scores ranged in the middle were further excluded. As a result, the data from a total of 37 students (17 males and 20 females) were considered in the final analysis.

3.2. Reading texts and target words

Two texts were adapted from two Internet sites (http://mrnussbaum.com & https://en.islcollective.com): one narrative, *The Toad's Dream*, and one expository, *The Narwhal*. Each text was measured using the Flesch-Kincaid Grade Level, a readability test initially developed in 1948 by Flesch (1948) and subsequently refined by Kincaid et al. (1975). This measure assesses text comprehension by analyzing sentence length and word complexity. A higher score corresponds to a more difficult reading level, aligned with a higher US grade level. The reading passages in the English textbook at the participating school had an average score of 7.66, which aligns with a 7th-grade reading level in the US school system. The readability scores of the two texts used for the present study were lower than this average (5.7 and 6.0, respectively), suggesting that they were easier for the participants of the study to read and understand. Additionally, the lexical coverage was checked to make sure that the words contained in each text were already familiar to the students.

Sixteen lexical items were chosen evenly from the two texts: eight per text, each appearing only once in each text. Care was taken to select the words whose meanings are accessible through contextual clues. They were then substituted with pseudowords to ensure no one had prior knowledge of the targets. The pseudowords were carefully invented based on the ARC Nonword Database (Rastle et al., 2002), following the orthographic and morphological rules of English. Therefore, it was expected that out of the two experimental texts, 16 target words would be unknown to the students. Table 1 shows more detailed information about the two experimental texts and the target words.

Table 1 Experimental texts and target words

Category	*The Toad's Dream* (narrative)	*The Narwhal* (expository)
Number of words	360	314
Number of sentences	19	25
Number of words per sentence	18.9	12.5
Flesch-Kincaid grade level	5.7	6.0
Target pseudowords	lear (yearn)	mawn (organ)
	mizzing (buzzing)	rist (defend)
	gridle (rein)	dangy (drab)
	roap (cultivate)	seap (suck)
	sanotic (naughty)	hodet (pod)
	skot (whip)	blurdy (murky)
	linch (trap)	voicashly (extremely)
	greach (fetch)	hoast (predator)

3.3. Tests

3.3.1. Vocabulary levels test (VLT)

The prior vocabulary knowledge of the participants was measured by the VLT. Developed by Nation (1983), the test underwent a revision in 2001 by Schmitt et al. (2001). Among the five frequency levels of the English word families (i.e., 2,000, 3,000, 5,000, 10,000, and academic vocabulary), the present study used a 2,000-word level test. This decision was based on the Korean English Vocabulary Guide from the 7th National Curriculum which requires high school students to master a vocabulary size of at least 1,200 and 3,000 maximum. The VLT consisted of 10 items, each item listing six words and three definitions. The participants had to match one of the six words from a list on the left to its corresponding definition on the right. One point was awarded for each correct item, making the possible maximum score 30 points (see Figure 1).

1 copy		
2 event	.....	end or highest point
3 motor	.....	this moves a car
4 pity	.....	thing made to be like another
5 profit		
6 tip		

Figure 1 Sample test items of the VLT

3.3.2. Reading span task (RST)

The reading span task (RST) was first introduced by Daneman and Carpenter (1980) and has been used in many studies for the measurement of WMC. Conway et al.'s (2005) RST, described in Unsworth et al. (2005), was used in this study, due to its internal consistency and reliability, and positive correlation with other WMC measures. Weak or no relationship was found between incidental vocabulary gains and WM measured by simple span tasks in several previous studies (de Leeuw et al., 2014; Malone, 2018; Varol & Erçetin, 2016). According to Linck et al.'s (2014) meta-analysis exploring the role of WM in L2 comprehension and production, the executive control aspect of WM, as assessed by complex span tasks, is more strongly connected to L2 learning success than its storage component, measured by simple span tasks. Additionally, verbal span tasks are better predictors of L2 outcomes compared to nonverbal span tasks (Linck et al., 2014). Accordingly, this study used a verbal complex span task to assess the participants' WM, addressing both the processing and storage components.

RST (Conway et al., 2005) was delivered on the computer using a platform created with C++ language in this study. A total of 42 English sentence-letter trials were randomly given in 12 sets, and those 12 sets were distributed across four levels, from level 2 to level 5. Three sets of sentences were given per level. The level refers to the number of sentences presented in each set. For example, at level 2, students had three sets of tasks consisting of two sentences. To enhance the task's suitability for participants, the RST was modified by removing challenging vocabulary and subsequently reviewed by two native-speaking English teachers. The average length of the sentence was 11 words. Half of the 42 sentences were semantically acceptable, and the other half were semantically implausible. During the task, the participants read the English sentence on each slide and determined whether the sentence was semantically plausible (e.g., **Sue was very happy to hear from her old wall*). They also had to remember the letter (e.g., *K*) that came after each sentence stimulus. Each time a set was finished, a recall task appeared on the screen for the participants to type in the

letters in the right order. For scoring, traditionally, Daneman and Carpenter (1980) used the absolute span scoring method, which calculated correct words recalled based on the boundary of a set the word belongs to. This meant that if a participant had two words incorrect in a set of three sentences, the score was 0, allowing no partial points. However, Conway et al. (2005) and Juffs (2005) considered this method to be problematic for the reason that it does not count plausibility judgment in total score, and the small range of scores does not allow clear discrimination among individuals. Thus, this study applied the partial credit scoring suggested by Conway et al. (2005), which calculates the number of every letter correctly recalled from correctly judged sentences. The maximum possible score was 42 points. Figure 2 illustrates how each set of the RST operated.[1]

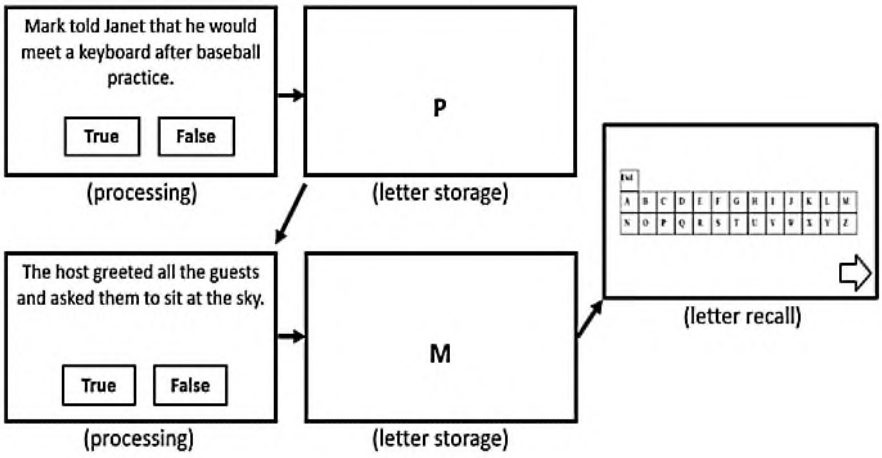

Figure 2 Sample of the RST (level 2)[2]

3.3.3. Word form recognition test and word meaning recognition test

Two measures were used to assess incidental vocabulary gains, focusing on two aspects of word knowledge: form and meaning. To evaluate participants' ability to recognize the correct spelling of the target words, they completed a word form recognition test based on a multiple-choice format (Pellicer-Sánchez & Schmitt, 2010; Waring & Takaki, 2003). An item included five possible options:

[1] Since the WM span task was carried out in the participants' L2, confounding effects with L2 proficiency might exist. One reviewer correctly pointed out this issue.

[2] Figure 2 is a schematic diagram of the RST (Conway et al., 2005). The image is an original work created by the authors of this study to enhance understanding of the task procedure.

one correct answer, three distracters, and a "Don't know" option. Particular care was taken to invent the three distracters to be morphologically and phonologically similar to each target word (see Figure 3). A word meaning recognition test was administered to assess the participants' knowledge of word meanings. It was also a prompted five-choice recognition test with one correct answer, three distracters, and a "Don't know" option (Pulido, 2007a). All the options were presented in the participants' L1, Korean (see Figure 3).

sanotic ① sunotic ② sinotic ③ senotic ④ sanotic ⑤ Don't know

mizzing ① 조용한 ② 침체된 ③ 아름다운 ④ 와글거리는 ⑤ Don't know

Figure 3 Sample test items of word form recognition test and meaning recognition test

3.4. Procedures

The study was carried out in two phases during regular class hours. All tests were administered on paper, except for the RST, which was conducted on a computer and therefore took place in a computer lab. Participants took the tests individually without discussing the target words with others and without access to dictionaries or digital devices. In the first phase, all the participants completed the paper form of the VLT in 10 minutes in their classrooms under the supervision of their homeroom teachers. Then, after receiving sufficient explanation and practice, the RST was administered to several groups of about 10 students in the school's computer room due to a lack of computers and for the convenience of monitoring and guiding. The order of the sentences and the letters was arranged through a random number generator program. After the RST, each participant read both narrative and expository texts at their own pace. While reading, they were required to complete two reading activities: a story map and a multiple-choice comprehension task composed of eight items. Those reading activities did not include any of the target words. This was done to make sure that the participants read the texts at least two times and avoid paying special attention to the target words. To reduce any carryover effects, all texts, reading activities, and posttests were divided into two different sets, A and B. Half of the students performed Set A first and then Set B, and the other half performed Set B first, followed by Set A to allow counterbalancing. Upon the completion of the reading activities, the participants immediately took posttests; first, they took the word form recognition test, and then they took the word meaning recognition test. In line with Hulstijn's (2006) recommendation that there should be no prior

notice of vocabulary tests in incidental vocabulary learning, students were not informed beforehand that they would be taking a vocabulary test. The post-reading vocabulary form assessment was conducted only after all reading passages and reading comprehension materials had been collected. After a two-day interval, without any announcement, the two tests were given again as delayed posttests. The same test items were used in the two posttests but in a different order.

To assess the suitability of the reading materials and tests used in the study, a pilot test was conducted during regular class hours. Four first-year female students from a different class, who were not part of the study group but had similar English proficiency with the test groups, were briefed and participated in a series of tests: vocabulary knowledge, reading span task, text reading and comprehension, and post-reading vocabulary assessments. The results of the pilot test indicated that students found it very difficult to write the meanings of given words in the blanks during the post-reading meaning assessment. As a result, the word meaning recognition test based on Waring and Takaki (2003) was modified to multiple-choice questions (Pulido, 2007a) where students could select the Korean meaning of the given English word.

This study was conducted with the approval of the school principal and the cooperation of the participating students' homeroom teachers. To prevent participants from excessively focusing on the target vocabulary during reading, they were informed that the experiment aimed to measure memory capacity. The researchers provided participants with a detailed explanation of the entire experimental procedure, expected duration, schedule, and necessary precautions, excluding information about the post-reading vocabulary tests. After receiving this explanation, participants voluntarily signed consent forms. Upon completion of all experiments, each participant received a monetary reward for their participation.

3.5. Data analysis

Text type, prior vocabulary knowledge, and WMC served as three independent variables in this study. The effects of each categorical variable on vocabulary gains and retention were measured through a word form recognition test and a word meaning recognition test. Therefore, the dependent variables in this study were the form recognition test scores and the meaning recognition test scores. The participants were divided into high and low groups based on their VLT and RST scores, and independent samples *t*-tests were conducted to ascertain the group differences in test scores. Then, after ensuring the normality and sphericity assumptions, a three-way repeated-measures ANOVA was run to determine the statistical significance of the effects of the main variables. All results were

interpreted at a significance level of .05. Next, for the immediate and delayed posttest results, the effect size of each independent variable was calculated using Cohen's *d*, whose values of .20 and smaller, .20 to .80, .80 and greater were considered small, medium, and large, respectively (Cohen, 1988).

4. Results

4.1. Prior vocabulary knowledge and WMC of the participants

Table 2 presents the VLT scores of the high and the low prior vocabulary knowledge groups. Independent samples *t*-test indicated that the means of the two groups were significantly different from each other, $t(35) = 15.18$, $p < .001$.

Table 2 Vocabulary levels test (VLT) scores

Group	*N*	*M*	*SD*	*t*	*p*
High PVK	21	26.57	1.56	15.18	.00
Low PVK	16	14.44	3.22		

Note. PVK = prior vocabulary knowledge

Table 3 provides the RST scores of the high and the low WMC groups. The independent samples *t*-test indicated that the means of the two groups were significantly different from each other, $t(35) = 8.01$, $p < .001$.

Table 3 Reading span task (RST) scores

Group	*n*	*M*	*SD*	*t*	*p*
High WMC	20	29.15	3.22	8.01	.00
Low WMC	17	18.06	5.12		

Note. WMC = working memory capacity

4.2. Immediate learning of word forms

Table 4 illustrates the descriptive statistics for vocabulary gains on the word form recognition test conducted during the immediate posttest. The results of the form recognition test showed that the overall mean score was higher with the narrative text *(M* = 4.08) than with the expository text (*M* = 3.65). The vocabulary gains according to the VLT scores revealed that the gain of the high PVK group (*M* = 4.35) was greater than that of the low PVK group (*M* = 3.29). The gain of the participants with high WMC (*M* = 4.40) was greater, compared to the gain of the participants with low WMC (*M* = 3.24). Specifically, in the narrative text,

the high PVK group (*M* = 4.52) scored higher than the low PVK group (*M* = 3.50). Similarly, in the expository text, the high PVK group (*M* = 4.16) outperformed the low PVK group (*M* = 3.11). Likewise, the gain score of the high WMC group (*M* = 4.65) was higher than that of the low WMC group (*M* = 3.41) in the narrative text, and a similar pattern was observed in the expository text (high WMC: *M* = 4.15, low WMC: *M* = 3.06).

Table 4 Descriptive statistics for the form recognition test: Immediate posttest

	Group	Narrative text		Expository text		Total	
		N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
PVK	High	21	4.52 (1.66)	21	4.16 (1.34)	42	4.35 (1.51)
	Low	16	3.50 (1.15)	16	3.11 (1.52)	32	3.29 (1.36)
WMC	High	20	4.65 (1.66)	20	4.15 (1.27)	40	4.40 (1.48)
	Low	17	3.41 (1.06)	17	3.06 (1.60)	34	3.24 (1.35)
	Total	37	4.08 (1.53)	37	3.65 (1.51)	74	3.86 (1.53)

Note. PVK = prior vocabulary knowledge; WMC = working memory capacity

A three-way repeated-measures ANOVA revealed statistically significant main effects of WMC, $F(1, 66) = 6.71$, $p < .01$, $eta^2 = .09$. Its effect size was also found to be large, $d = .82$. However, there were no significant main effects of the text type factor, $F(1, 66) = 1.14$, $p = .28$, $eta^2 = .02$, $d = .28$, and of the PVK factor, $F(1, 66) = 4.04$, $p = .05$, $eta^2 = .06$, $d = .74$. Also, the three two-way interactions among the three factors and their three-way interaction were not statistically significant (all $p > .05$).

4.3. Immediate learning of word meanings

Table 5 shows the descriptive statistics for vocabulary gains on the word meaning recognition test. The overall mean score was higher for the narrative text *(M* = 3.70) than for the expository text (*M* = 3.41). The vocabulary gains according to the VLT scores revealed that the gain of the high PVK group (*M* = 4.40) was higher than that of the low PVK group (*M* = 2.56). The gain of the participants with high WMC (*M* = 4.30) was greater, compared to the gain of the participants with low WMC (*M* = 2.68). To be more specific, the high PVK group (*M* = 4.33) scored higher than the low PVK group (*M* = 2.88) from the narrative text. The high PVK group (*M* = 4.47) also remembered words' meanings better than the low PVK group (*M* = 2.28) using the expository text. The gain score of the high WMC group (*M* = 4.10) was also higher than that of the low WMC group (*M* = 3.24) in the narrative text, and a resembling pattern was found in the expository text (high WMC: *M* = 4.50, low WMC: *M* = 2.12).

Table 5 Descriptive statistics for the meaning recognition test: Immediate posttest

	Group	Narrative text		Expository text		Total	
		N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
PVK	High	21	4.33 (1.02)	21	4.47 (1.58)	42	4.40 (1.30)
	Low	16	2.88 (1.63)	16	2.28 (1.74)	32	2.56 (1.69)
WMC	High	20	4.10 (1.69)	20	4.50 (1.57)	40	4.30 (1.52)
	Low	17	3.24 (1.39)	17	2.12 (1.62)	34	2.68 (1.59)
	Total	37	3.70 (1.49)	37	3.41 (1.98)	74	3.55 (1.74)

Note. PVK = prior vocabulary knowledge; WMC = working memory capacity

Results of the three-way repeated-measures ANOVA indicated statistically significant main effects of PVK, $F(1, 66) = 18.68$, $p < .01$, $eta^2 = .22$, and of WMC, $F(1, 66) = 10.34$, $p < .01$, $eta^2 = .14$. Their effect sizes were calculated to be as large as 1.22 and 1.04, respectively. However, the main effects of text type were not significant, $F(1, 66) = .45$, $p = .50$, $eta^2 = .01$, $d = .17$. As for the interaction effects among the three factors, only the two-way interaction between text type and WMC was found to be statistically significant, $F(1, 66) = 5.18$, $p < .05$, $eta^2 = .07$. This interaction may suggest that depending on the extent of WMC, the impact of text type on incidental vocabulary learning could be different. In other words, as shown in Figure 4, there was no large difference between the scores of the high WMC group and the low WMC group in the meaning recognition test from the narrative text, but in the case of the expository text, the score decreased significantly in the low WMC group. To put it another way, the group with low WMC was greatly influenced by the text type factor in remembering the meaning of new words through reading, and they found the expository text more difficult than the narrative text. On the other hand, the high WMC group scored high in both texts but tended to show a little higher scorings in the expository text (see Figure 4).

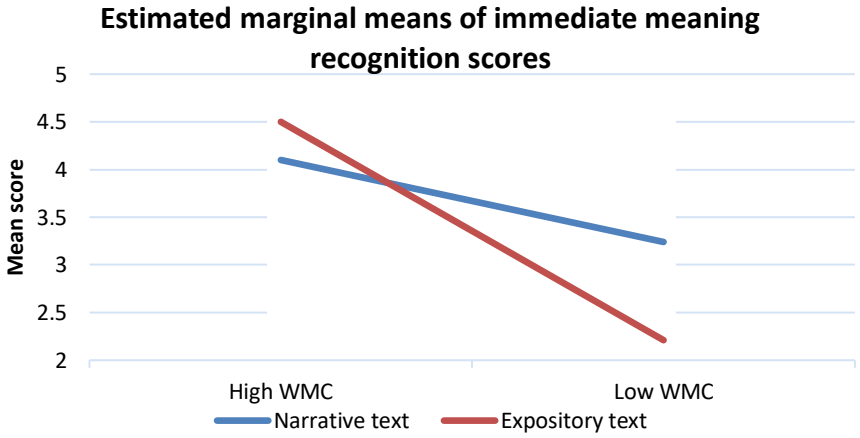

Figure 4 Interaction of text type and WMC on the immediate meaning recognition test

4.4. Delayed learning of word forms

Table 6 illustrates the descriptive statistics for the results from the delayed word form recognition test. The overall mean score of the narrative text *(M* = 3.78) was found to be a little higher than that of the expository text (*M* = 3.32). The word retention according to the VLT scores revealed that the performance of the high PVK group (*M* = 4.25) was higher than that of the low PVK group (*M* = 2.74). This pattern was also observed with WMC as the participants with high WMC remembered the word forms better (*M* = 4.28) than those with low WMC (*M* = 2.71). More specifically, from the narrative text, the high PVK group (*M* = 4.29) scored higher than the low PVK group (*M* = 3.13). From the expository text, the high PVK group (*M* = 4.21) also performed better than the low PVK group (*M* = 2.39). Moreover, the high WMC group (*M* = 4.40) remembered the form of target words better than the low WMC group (*M* = 3.06) in the narrative text.

Table 6 Descriptive statistics for the form recognition test: Delayed posttest

	Group	Narrative text		Expository text		Total	
		N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
PVK	High	21	4.29 (1.74)	19	4.21 (1.40)	42	4.25 (1.56)
	Low	16	3.13 (1.41)	18	2.39 (1.46)	32	2.74 (1.46)
WMC	High	20	4.40 (1.60)	20	4.15 (1.50)	40	4.28 (1.54)
	Low	17	3.06 (1.52)	17	2.35 (1.37)	34	2.71 (1.47)
	Total	37	3.78 (1.69)	37	3.32 (1.68)	74	3.55 (1.69)

Note. PVK = prior vocabulary knowledge; WMC = working memory capacity

Results of the three-way repeated-measures ANOVA revealed statistically significant main effects of the PVK factor, $F(1, 66) = 9.22$, $p < .01$, $eta^2 = .12$, and the WMC factor, $F(1, 66) = 11.25$, $p < .01$, $eta^2 = .15$. Their effect sizes were as large as $d = 1.00$ and $d = 1.04$. The main effects of the text type factor, however, were not significant, $F(1, 66) = 1.12$, $p = .29$, $eta^2 = .02$, $d = .27$. None of the three two-way interactions or the three-way interaction among the three factors were statistically significant (all $p > .05$).

4.5. Delayed learning of word meanings

Table 7 illustrates the descriptive statistics for vocabulary retention on the word meaning recognition test. It was found that the overall mean score of the narrative text *(M* = 4.00) was higher than that of the expository text (*M* = 3.22). The retention of the high PVK group (*M* = 4.18) was better than that of the low PVK group (*M* = 2.94). Also, the high WMC group scored higher (*M* = 4.35) than the

low WMC group (*M* = 2.74). In specific, the high PVK group (*M* = 4.48) scored higher than the low PVK group (*M* = 3.38) from the narrative text, and the high PVK group (*M* = 3.84) also remembered word meanings longer than the low PVK group (*M* = 2.56) when reading the expository text. The retention score of the high WMC group (*M* = 4.50) was also higher than that of the low WMC group (*M* = 3.41) in the narrative text, and the gap was even greater in the expository text (high WMC: *M* = 4.20, low WMC: *M* = 2.06).

Table 7 Descriptive statistics for the meaning recognition test: Delayed posttest

	Group	Narrative text		Expository text		Total	
		N	*M*(*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
PVK	High	21	4.48 (1.08)	19	3.84 (1.46)	42	4.18 (1.30)
	Low	16	3.38 (2.00)	18	2.56 (1.50)	32	2.94 (1.77)
WMC	High	20	4.50 (1.43)	20	4.20 (1.47)	40	4.35 (1.44)
	Low	17	3.41 (1.66)	17	2.06 (0.75)	34	2.74 (1.44)
	Total	37	4.00 (1.62)	37	3.22 (1.60)	74	3.61 (1.65)

Note. PVK = prior vocabulary knowledge; WMC = working memory capacity

The three-way repeated-measures ANOVA revealed that all the main factors had statistically significant effects on the participants' delayed learning of word meanings: text type, $F(1, 66) = 5.45$, $p < .05$, $eta^2 = .08$; PVK, $F(1, 66) = 4.73$, $p < .05$, $eta^2 = .07$; WMC, $F(1, 66) = 15.49$, $p < .01$, $eta^2 = .19$. Their effect sizes were found to be $d = .49$, $d = .80$, and $d = 1.12$, respectively. However, all the three two-way interactions and the three-way interaction among them were not significant (all $p > .05$).

5. Discussion

The present study was designed to examine how incidental vocabulary gains and retention through reading are influenced by learner-external factors, such as text type, as well as learner-internal factors, such as the learners' prior L2 vocabulary knowledge and their WMC.

Regarding the effects of text type, no statistically significant difference was observed on the immediate posttests; however, the text type factor was found to have significant effects in the meaning recognition test on the delayed posttest. These results may indicate that the text type factor might bring about some detectable, meaningful change in L2 learners' vocabulary knowledge in the longer term. Also importantly, vocabulary retention was superior after reading the narrative text as opposed to the expository text. While the literature acknowledges the distinct impacts of narrative and expository texts on reading

comprehension (Best et al., 2008; Clinton et al., 2020; Graesser et al., 2003; Härtig et al., 2022; McNamara et al., 2012), our findings emphasize that these text types also differentially influence vocabulary acquisition, corroborating previous findings (Nguyen, 2023; Shokouhi & Maniati, 2009; Webb et al., 2023). Unlike Nguyen (2023) and Shokouhi and Maniati (2009), where learners who read expository texts excelled in incidental vocabulary acquisition compared to those reading narratives, this study found that narrative texts tended to support vocabulary inferencing and retention more effectively than expository texts. It might be that, with their coherent storylines and character-focused content, as Shokouhi and Maniati (2009) also acknowledged, narrative texts encouraged the use of inferencing skills and consequently eased incidental vocabulary learning. Narrative texts, with their linear and cohesive structures, have been shown to facilitate inferential comprehension more effectively than expository texts (Clinton et al., 2020). The current study aligns with the study by Gardner (2004), which found that narrative texts tend to use more common words and provide a familiar storyline that helps learners predict and infer the meanings of unknown words. This structure supports vocabulary acquisition by enabling readers to integrate new words into their existing mental frameworks more seamlessly.[3]

It was found that learners with greater prior vocabulary knowledge demonstrated significantly enhanced incidental vocabulary acquisition, in line with previous studies (Feng & Webb, 2020; Webb & Chang, 2015). As evidenced by posttests, while vocabulary knowledge showed medium effect size (d = .74) in the immediate form recognition, it showed greater effect (d = 1.22) in the immediate meaning recognition. This effect persisted in long-term memory, with significant influences on both form (d = 1.0) and meaning recognition (d = .80). Contrary to Teng's (2024) results, where prior vocabulary knowledge significantly impacted form and meaning recognition in immediate posttests but not in delayed posttests, our study found that the high PVK group maintained their advantage in both immediate and delayed assessments. Our study also sought to determine whether learners with rich prior vocabulary knowledge would outperform those with limited knowledge in vocabulary learning through reading various types of texts. No significant interaction effects were found between VLT scores and the text variables. This indicates that the advantage of high prior vocabulary knowledge was consistent across different texts. In fact, the high PVK group outperformed the low PVK group on both immediate and

[3] One part of the findings that merits attention is that the meaning recognition test scores in the delayed posttests were higher than the immediate posttests in all groups. This result may suggest that the superior learning condition fostered by the narrative text type would be getting stronger in the long term. This interpretation would just be pure speculation, however, because the delayed posttest was administered just two days after the posttest.

delayed posttests, regardless of whether the text was narrative or expository. This suggests that learners with higher prior vocabulary knowledge can leverage their existing vocabulary to better infer and learn new words, regardless of text type.

Regarding the final main factor of the study, the robust, significant effects of WMC were consistently revealed across all posttests. The results may support the argument made by Daneman and Merikle (1996) and Linck et al. (2014) that WMC is a key predictor of language learning success. The effect sizes of WMC throughout all tests were large (d > .80), and they were found to be even larger (d > 1.0) in the delayed posttests. Sharing similar findings with Malone (2018) and Teng (2024), this result suggests that as WMC increases, the likelihood of using surrounding context to learn new words may increase, and the increase in the chances of storing them in long-term memory is even greater.

Supporting the meta-analysis by Webb et al. (2023), the interaction effects between text type and WMC in the immediate meaning recognition test suggest that the level of WMC of individual learners may affect the results of L2 incidental vocabulary learning differently in each text type. The high WMC group did not show a significant difference in vocabulary gains between the two text types, while the low WMC group experienced more pronounced gains from the narrative text. Clinton et al. (2020) and Best et al. (2008) suggested that the content and structural nature of narrative texts can reduce the cognitive burden on learners, influencing the ease of inferential comprehension tasks. Based on these previous findings, we assume that low WMC learners relied on their existing knowledge of common story structures to make inferences without expending significant cognitive resources, facilitating comprehension and vocabulary learning. While expository texts seemed to demand higher processing capacity from low WMC learners due to their complex structures and specialized knowledge (Best et al., 2008), high WMC learners showed superior performance on vocabulary tests after reading. It is assumed that high WMC learners may have had greater ability to process and store unknown words in the expository text by relying on complexly structured sentences containing less familiar information (Best et al., 2008; Clinton et al., 2020; Hulstijn, 2001). Those with a stronger ability to hold and manage information in their minds were also better at handling multiple tasks simultaneously, which Revész (2012) described as "a greater ability to focus, divide, and switch attention among various task demands" (p. 123). This ability may explain their superior performance on vocabulary tests.

This study revealed that participants with higher RST scores demonstrated greater vocabulary gains, aligning with previous research that utilized complex span tasks (Malone, 2018; Montero Perez, 2020; Teng, 2024). It has been noted that empirical studies such as de Leeuw et al. (2014), and Varol and Erçetin (2016) have shown mixed results concerning WMC's influence on incidental vocabulary

learning, particularly when simple span tasks were used. These study findings led us to predict that complex span tasks like the RST, which assess both processing and storage capabilities, would provide a more comprehensive measure of WMC. The current study corroborates this expectation by showing that higher WMC was associated with better performance on both immediate and delayed posttests, highlighting the importance of WMC in vocabulary retention.

Caution should be exercised when interpreting the findings of this study due to some limitations in its design. First, a small sample size of 37 participants may have limited the study's ability to draw definitive conclusions. Follow-up studies that include a larger participant pool are deemed necessary. Additionally, the RST was administered in groups due to constraints in time and space, although the use of a random number generation program ensured that sentences and letters were presented randomly to the participants. However, conducting the task individually would have provided a more precise assessment of the role of WM, and future research should consider the method of RST administration with greater attention. Lastly, the delayed posttests were conducted at a two-day interval due to time constraints imposed by the participating school's class schedule. The large effect sizes observed for prior vocabulary knowledge and WMC may have been influenced by this short interval. Exploring the durability of the benefits from incidental vocabulary learning would be a viable topic for future research.

6. Conclusion

This study examined the effects of text type, prior vocabulary knowledge, and working memory capacity (WMC) on incidental vocabulary learning in L2 contexts. The findings underscore the importance of considering both learner-internal and learner-external factors in designing effective vocabulary acquisition strategies. Notably, text type was found to have moderate effects on vocabulary retention, indicating overall better learning outcomes from reading the narrative text than the expository text. This study was also able to reconfirm how important it is for L2 learners to be equipped with sufficient prior vocabulary knowledge when they want to benefit more from incidental vocabulary learning through reading. Additionally, it was found that language learning aptitude in terms of WMC (specifically measured by complex span tasks like the RST) contributed substantially to incidental vocabulary learning, but with different amounts of effects depending on the individual level of WMC.

Some pedagogical implications can be drawn from the study. To enhance incidental vocabulary learning, educators should prioritize building learners' vocabulary breadth and depth as prior vocabulary knowledge significantly benefits

vocabulary acquisition across all text types. By pre-teaching essential vocabulary before engaging with complex and unfamiliar texts, learners can better manage the cognitive demands of these materials. Instructional strategies should be tailored to individual differences, particularly WMC. For learners with lower WMC, scaffolding techniques and additional support are essential when navigating complex texts, allowing them to gradually build their cognitive skills and improve vocabulary retention. Recognizing the cognitive and affective advantages of narrative texts, educators can create a more engaging learning environment by incorporating them into L2 curricula, which facilitates better vocabulary retention. Meanwhile, expository texts should be strategically used for learners with high WMC to challenge and develop their cognitive processing skills. These texts demand higher cognitive engagement, beneficial for learners capable of handling the increased cognitive load, thereby fostering deeper learning and enhancing critical thinking skills.

Future research should explore a broader range of text types, including extensive reading, digital and multimedia formats, to assess their impact on incidental vocabulary acquisition. Longitudinal studies are essential to investigate the durability of vocabulary gains over extended periods and examine how various teaching interventions can sustain vocabulary growth. Additionally, further research should examine other learner-related variables, such as motivation and anxiety, and their interactions with text type and cognitive capacities in vocabulary learning. Developing more sophisticated tools for assessing WM could also provide deeper insights into the cognitive processes underlying vocabulary acquisition. This study adds to the expanding body of research on incidental vocabulary learning by highlighting the complex interplay between text type, prior vocabulary knowledge, and cognitive capacities, offering valuable insights for educators and researchers aiming to optimize vocabulary learning in L2 contexts.

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