Research Article

A Study on the Application of Computer-Aided Dual-Coding Theory in English Vocabulary Teaching

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Learning English needs a huge amount of vocabulary recalls as well as multiple grammatical structures and practices. With the development and improvement of the humanization and quality of English teaching, the multidimensional teaching of English has formed a powerful learning model and teaching method. The teaching of dual-coding theory assisted by computer teaching software mainly focuses on the dual activation representation of language combined with nonverbal graphic recognition to complete the recognition of information. According to the dual-coding hypothesis, in Gilford’s intelligence theory, the capacity of spatial and information recognition and reading is highly significant. With the large amount of visual recognition and information acquisition, images involve spatial domain information reading, which is a learning method based on the principle of information feature recognition. Based on the principle of dual-coding theory, it is a very effective way to present information and recall specific information in the form of vision and language. In this study, the application research for the purpose of English vocabulary teaching is adopted that has strong innovative and practical characteristics. According to the steps and contents of English vocabulary learning, the study is carried out step by step from the context in detail, so it continuously improves the learning quality and efficiency of English vocabulary teaching. Vocabulary teaching can help the students better improve their cognitive level of vocabulary and meet the vocabulary test requirements of the new institution entrance examination. Further, how to improve the effect of senior high school English vocabulary teaching is a major topic in the field of senior high school English teaching. In order to sort out this issue, I proposed a computer-aided dual-coding theory to help quickly understand vocabulary usage in order to increase learning efficiency. The Paivio–Desrochers model is used in this study. In addition, this study also attempts to explore the application of dual-coding theory in senior high school English vocabulary teaching.

1. Introduction

According to the dual-coding theory (DCT), human brain uses both verbal and visual information for the storage and representation of information, but the human mind processes this information differently with the help of two separate channels [1]. The dual-coding theory (a theory of cognition) was proposed by the Canadian psychologist Allan Paivio of the University of Western Ontario in 1971. Paivio based his hypothesis on the idea that the development of mental images enhances learning [2]. He put forward the dual-coding theory of long-term memory. Based on long-term memory, memory methods are divided into two systems: image system and semantic system. Representation and semantics are two parallel and related cognitive systems. Representation system uses representation code to store information and semantic system stores information with the help of semantic code [3]. People’s visual representations are particularly developed, and they can be activated by relevant inspirations, respectively. Semantic code is an abstract representation of meaning. Some discrete materials are organized due to meaningful connections, making memory relatively easy [4].

Paivio found in his experiment that the fastest recognition is made by the help of dual memory of images and words. The fast and direct image is produced by the content recalled from pictures and words [5]. The combination of information and tools has certain advantages. The brain's memory effect and speed of image materials are slightly better than those of simple semantic memory. The theory
describes the human cognitive process, which includes two different but interrelated input channels: verbal and non-verbal systems. One processing system is responsible for processing based on language and the other processing system is responsible for processing based on images. In other words, one is responsible for the handling of information and the other is responsible for the storage and extraction of information [6]. Yan and Filieri [7] make a 5-minute experiment. In this experiment, (A) is used to recall the pictures and words together while (B) is used to remember the words and visuals separately. Yan et al. [8] also conducted such an experiment, using a primate gorilla with the same brain as human beings, but with a smarter brain. When gorilla remembers a picture for only 0.3–0.5 seconds, the memory effect of sound plus picture is more significant.

According to the dual-coding theory, there are two processing systems with independent but interrelated functions in the human brain: one processing system is based on language, and the other processing system is based on image [9]. Image system is specific for representing and processing nonverbal objects and events. It is composed of image representations with associative relationship. Cognition is supported by two special representation systems, which come from experience and have obvious differences in expressing and processing information about nonverbal objects, events and linguistic information [10]. Combined with English research, in the current process of English vocabulary teaching, more and more students begin to feel the pressure of vocabulary memory and application, which also highlights the shortcomings of current English vocabulary teaching. In other words, for getting a deep insight about a language and to speak fluently, vocabulary memorization and understanding is playing a vital role in this regard [11]. On the basis of DCT, we understand that in senior high school English vocabulary teaching, we should not only pursue the image of vocabulary itself in form, but also further strengthen the processing of its overall change around the change of vocabulary and the application of vocabulary [12]. Through this changing teaching, we can improve students’ level and ability of vocabulary perception so as to deepen their impression and complete the predetermined vocabulary teaching objectives. For example, for the changing forms of verbs, a good memory bridge is formed with the help of certain context to help students input vocabulary and encode vocabulary so as to lay the foundation for the subsequent retrieval of vocabulary information [13].

In order to promote the students’ vocabulary processing cognitively, this study determines that the dual-coding theory can improve English vocabulary learning, improve the overall language vocabulary level, and enrich their own vocabulary reserves through word roots, affixes, and other ways. In this way, an overall dual-coding framework is formed, which creates favorable conditions for subsequent vocabulary application and vocabulary extraction [14]. In the process of guiding students’ cognitive processing, we should also start from students’ cognitive behavior characteristics and cognitive tendency, create a more favorable language cognitive environment for students through the enrichment of language culture and relevant background knowledge materials, and also play the role of the combination of vocabulary cognition and dual-coding theory. By creating a good cognitive incentive system, students are encouraged to actively explore, actively construct, and actively double code so as to provide a good foundation for senior high school English vocabulary teaching in the future [15]. In the process of encouraging students, we can appropriately adopt the way of word memory competition, let students improve the effect of word memory with the help of game level interaction, and realize the effectiveness and persistence of coding through rich and colorful double construction activities [16].

Finally, the evaluation system of vocabulary teaching needs to be improved. Nowadays, the process of English vocabulary teaching, relevant evaluation indicators, and contents of vocabulary teaching are mainly through reading comprehension and grammar [16]. Test modes like fill in the blanks and other related specific questions of word base lack English vocabulary teaching. Fill in the blanks and other related specific questions, which is lack of word-based test methods and test modes. Therefore, how to proceed from the current situation and further explore the idea of overall English vocabulary teaching evaluation is particularly important. In short, from the above analysis, it can be seen that in the current process of English vocabulary teaching the use of dual-coding theory and technology is applied to the process of English vocabulary teaching. The research on these methods, strategies, and environmental evaluation system of vocabulary teaching is still in the initial stage, and there is still a lot of study space. Using this innovative research method, we want to put forward specific research ideas and processes, which lays a foundation for follow-up research. The main contributions are as follows: (1) in this paper, we describe Paivio–Desrochers dual-coding theory and dual-coding theory of multimedia learning. (2) We summarized the applications of computer-aided dual-coding theory in English vocabulary teaching. (3) We closed our study with a summary of the predictions concerning the role of spatial ability in learning from words and pictures.

The rest of the paper is organized as follows. Section 2 illustrates the related work, Section 3 demonstrates the material and methods, and Section 4 represents the results and discussion. Finally, the research study is concluded in Section 5.

2. Related Work

Vocabulary is regarded as a complete set of words and phrases and is one of the three constructive parts of linguistic. It is a societal phenomenon that has occurred in the past. Liu and Ge [17] stated that the main difference between the English language native speakers and the nonnative speaker is the vocabulary of English, which indeed is very necessary for the fluency and better understanding of the English language. Without saying the vocabulary has less importance. In an English as a Second Language (ESL) class, teaching and understanding vocabulary requires a lot of time and effort. People are frequently disheartened from the
learning outcomes [18]. Therefore, people need a system that improves English vocabulary. So, this paper introduces a study on the application of computer aided dual coding theory in English vocabulary teaching. Fu and Xu [19] have worked on micro-English vocabulary system, which consists of the following sections:

(1) Mobile Learning
Mobile learning is a new learning mode in education that is built on today's mobile communication and computer technologies. The word "mobile" refers to the digitalize embodiment of interactive learning content [20]. Mobile learning is less reliant or limited than Web-based learning, and hence it overcomes the constraints of time and place. When and whenever feasible, the learning mode provides learners with new experiences.

(2) Microlearning
Adult learners are becoming more interested in microlearning, particularly in professional training. The term "micro" refers to microdevices that are modest, light, or small in size. It refers to little learning content as well as smaller learning media with a brief learning duration. Microlearning is concerned with the acquisition, storage, production, and transmission of tiny blocks of knowledge via a small and portable device. It provides a comfortable and enjoyable learning atmosphere and experience for students [21].

(3) Mobile Microlearning
Mobile microlearning is derived from on-demand learning, which is made by merging mobile technology (wireless and tiny devices) with microlearning mode. Mobile microlearning is found in a variety of learning environments. Mobile microlearning consists of two advanced features: first, flexibility in learning activities at any time and place and second, interactivity between learners and educators in both instances and relaxation [22].

2.1. Dual-Coding English Vocabulary Theory. Paivio presented the dual-coding hypothesis in 1971. According to the Paivio hypothesis, the value of linguistic and non-linguistic items is equal. He claims that human cognition is very specific when we process both verbal and non-verbal objects [23]. A verbal system processes not only writing and speech, but it also acts as a symbol for nonlinguistic objects like events and behaviors. The connotation of dual-coding theory and its assumption has two cognitive subsystems: one is dedicated to the representation and processing of nonverbal things and events (i.e., images), while the other is used for language processing [24]. The theory grips that it is very important for later information recognition to store lexical information by dual-coding language. The application of dual-coding theory can stimulate student’s image thinking and help them to gain new information with the help of the original knowledge reserve [25]. Dual-coding theory plays an extremely important role in student’s vocabulary memory, problem solving, concept learning, and overall language cognition. Figure 1 describes the concept of the dual-coding theory.

Figure 1 explains the processing of our cognitive system, which consists of verbal and nonverbal systems. It also consists of three levels of processing, which includes representational processing, referential processing, and associative processing. The top of the model shows that people’s cognitive process initially begins with sensory systems of verbal and nonverbal stimuli from the real environment [26]. As shown in the figure, the organization of the verbal system is sequential and hierarchical. It indicates that the verbal system works like a network. On the other side, the images in the nonverbal system are constructed in an overlapping and nested way.

2.2. Dual-Coding Theory of Multimedia Learning. Multimedia learning occurs when students create knowledge from the information offered in two or more modes, such as a graphically shown animation and audibly presented narrative. In a precise sense, our definition applies to the word “multimodal” (which refers to the concept that the learner uses more than one sense modality) rather than “multimedia” (which refers to idea that the instructor uses more than one presentation medium) [27]. Two separate sense modalities are visual and verbal processing, and two different presentation mediums are animation and narration. It is also worth noting that, in some cases, verbal content can elicit the development of visual representations and that visual material can elicit the construction of verbal representations.

A dual-coding theory of multimedia learning is summarized in Figure 2. Our version of dual-coding theory (Paivio, 1971, 1986; Clark and Paivio, 1991), which we adapted and modified from Paivio’s theory (Paivio, 1971, 1986; Clark and Paivio, 1991), provides a three-process account of how visually and verbally presented material may be integrated within the learner’s working memory during learning [28]. A verbal explanation, such as an oral narration, is delivered to the student in the top-left area of the picture. The learner creates a mental model of the system presented in the spoken explanation in working memory. Building a verbal representational link is the cognitive process of moving from an external to an internal representation of linguistic content (or verbal encoding) [25]. A visual explanation, such as an animation, is offered to the student in the bottom-left area of the picture. The learner creates a mental model of the visually presented system in working memory. Building a visual representational connection (or visual encoding) is the cognitive process of transitioning from an external to an internal representation of visual information, as illustrated by the second arrow. The development of referential links between the two mental representations, i.e., the mapping of structural relations between the two representations of the system, is denoted by the third arrow.
The overall process of English vocabulary teaching and its strategy is to stimulate student’s cognitive initiative and improve student’s motivation of vocabulary learning with the help of dual-coding theory to meet the predetermined vocabulary learning objectives [29]. In addition, the vocabulary teaching environment needs to be optimized. As we know, in the process of vocabulary teaching, the teaching environment can have a certain impact on the overall students’ vocabulary learning and teachers’ vocabulary teaching. At present, there are still some deficiencies in the hardware environment of vocabulary teaching and the software environment of vocabulary teaching [30]. This is another major factor affecting English vocabulary teaching.

From the overall perspective of research, the combination of computer-aided dual-coding theory into English vocabulary learning is an important effect, which can improve the effect of English vocabulary teaching. When studying the application of dual-coding theory, this paper adopts the memory method of picture and text, which can better and more effectively improve the quality of English vocabulary teaching.

3. Materials and Methods

3.1. Proposed Research Architecture Based on Allan Paivio’s Dual-Coding Theory. According to the idea stated in a literature review, students who accepted dual coding and picture creation interventions had a greater degree of vocabulary learning. The efficiency of computer-aided dual-coding theory in English vocabulary teaching based on DCT as a unique teaching approach is investigated in this research. The impact of computer-assisted learning on students’ learning vocabulary is examined using a framework based on DCT [31]. Figure 3 illustrates the proposed research architecture, which is based on Allan Paivio’s dual-coding theory.

The above diagram represents our cognitive system. There are two cognitive subsystems: one dedicated to the representation and processing of nonverbal objects and events (images) and the other to language.

The applications of dual-coding theory focus on different issues. In the field of English vocabulary, the application value of this paper mainly analyzes the direction of vocabulary potential memory and puts forward specific problems and contents [32]. The fundamental development of vocabulary and the use of visuals will be integrated and configured on the basis of a statistical relationship, which is analyzed in the following equations:

\[ \rho(i) = \frac{n_i}{n} \quad i = 0, 1, 2, \ldots, L - 1. \] (1)

In equation (1), \( \rho \) is risk model for the application of dual-coding theory in English vocabulary teaching, \( i \) is used for risk coefficient whose range is from 1 to \( L - 1 \). The greater value of \( i \) indicates that the risk is high. In this relationship, \( n_i \) value is used for risk judgment, \( (n_i/n) \) is used for risk proportion function, and the value of \( n \) represents the overall risk.
In equation (2), $E_k$ represents the overall valuation of phased risk, where $E$ stands for valuation, and $K$ is the number of stages. That consists of the early stage, the middle stage, and the later stage. According to the development trend of the application of dual-coding theory in English vocabulary teaching, it can be divided into more stage areas, which will not be considered for the time being, but there is possibility in the formula. So, it is expressed as $E_k$, and the $K$ value ranges from 1 to $L - 1$.

Dual-coding theory has more important application value than simple language memorization. Dual-coding theory can further mobilize students’ cognitive system. Through the dual processing of vocabulary language and intention, it can also help students improve the memory effect of vocabulary with the coordination of left and right brain. The difficulty of vocabulary memory and the mutual connection of pictures and words are recorded in Table 1.

According to Figure 4, with the increase of the number of images, the text content also increases correspondingly, and the difficulty of memory gradually decreases. This shows that while guiding students to increase vocabulary, they can also improve their familiarity with vocabulary and correct the spelling, application, and function of vocabulary. Therefore, the input of vocabulary information through dual coding not only help students construct the long-term memory of vocabulary, but also help students experience practical fun in the actual process, so as to avoid the phenomenon of burnout and low interest in the past vocabulary.

### Table 1: The statistics of dual-coding theory in vocabulary memory.

<table>
<thead>
<tr>
<th>Difficulty statistics (%)</th>
<th>Images</th>
<th>Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>65</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>45</td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td>32</td>
<td>8</td>
<td>46</td>
</tr>
</tbody>
</table>

3.2. **The Principles of Dual-Coding Theory in English Vocabulary Teaching.** In order to effectively apply dual-coding theory in the future to English vocabulary teaching, the dual-coding theory combined with English teaching should follow some basic principles, which include the following: first of all, the principle of interest according to the learning of English vocabulary teaching, vocabulary teaching should be carried out in combination with students’ cognitive characteristics and cognitive laws. Interest is not only the key teaching point around students’ memory, but also an important base for actual vocabulary memory. Therefore, according to the theoretical requirements of dual-coding theory, the teachers should provide good cognitive stimulation and guidelines to students. Second, the principle of development of dual-coding theory should be combined with the basic content of English vocabulary memory for effective learning. The records of English vocabulary in memory must build a better development foundation with the help of dual-coding theory.

Starting with the relevant basic theories such as “zone of proximal development,” this paper improves the cognitive quantity and difficulty of students’ English vocabulary. Through the application of this developmental principle, we can better help students improve their overall cognitive level of language and vocabulary. Third, according to the principle of pertinence, different students have certain personalized differences in the application of dual-coding theory. Especially with the continuous improvement of students’ requirements for the application of English vocabulary, it is particularly important to formulate corresponding personalized English vocabulary learning strategies and give full production to the processing effect of double coding on language materials. Based on the principle of pertinence, we need to follow the guiding ideology of personalized and differentiated teaching so as to better optimize the overall teaching structure and meet the needs of realizing the objectives of English vocabulary teaching.
The fourth one is the principle of innovation. In the field of English vocabulary teaching, we should pay attention to the innovation of teaching methods, teaching strategies, and teaching modes from the actual goal of English vocabulary or the application goal of English vocabulary teaching. At a certain level, dual-coding theory provides theoretical support for English vocabulary teaching. In the field of specific practical process, we should further innovate the relevant teaching system and teaching methods based on the objectives of English vocabulary teaching.

4. Results and Discussion

In this section, the experimental results are discussed. The acquisition of a specific vocabulary word while reading a story is best when there are both verbal and visual information. Based on the basic connotation of dual-coding theory and the relevant research results, this paper discusses the future application strategies from the following aspects. According to the application-oriented analyzing of double coding, the parsing type is classified into the following formula:

\[ \sum_{i=0}^{L-1} \rho(i) = \sum_{i=0}^{L-1} \frac{n_i}{n} \times E_{k(i,1,2,3,\ldots,L-1)} \leq 1. \]  

(3)

Here, \( \rho(i) = \frac{n_i}{n} \), \( i = 0,1,2,\ldots,L-1 \), is used to verify and analyze the overall judgment of the model. \( \sum_{i=0}^{L-1} \frac{n_i}{n} \) indicate memory coefficient and evaluation of phased memory difficulty and \( E_{k(i,1,2,3,\ldots,L-1)} \) determine products; if the value is less than 1, the difficulty is low. From this, we can conclude that the relative value of the obtained memory effect will be relatively high. On the contrary, when the value is larger or it is closer to 1, then the difficulty will be greater, and the relative benefit will be reduced. If it is equal to 1, the difficulty is 100% and the benefit is 0. Figure 5 describes the block diagram of dual-coding theory.

The above diagram represents the Paivio and Desrochers bilingual dual-coding theory for languages \( (L_1, L_2) \) with corresponding verbal systems \( (V_1, V_2) \), and an image system which connects these systems to each other. According to bilingual dual-coding theory, there exist separate but interconnected logogen systems for two languages \( (L_1, L_2) \), and each of which also connects to a nonverbal image system as shown in Figure 5. The dual-coding analysis of the combination of text and text, the methods and internal relations of learning vocabulary in the research strengthens the volume of the research results and their integration value. By designing the effectiveness of the dual-coding theory, we pay attention to the visualization of vocabulary teaching and language teaching. In this research work, we study the teaching effects under different models.

4.1. Picture and Text Loose-Decoration-Matching Style

The text corresponding to the picture in Figure 6 is to learn as much as possible about the eight planets of our Solar System. Remember that NASA (USA) has already sent spaceships to explore Jupiter and Mars, which can be found out from books and the Internet sources. Think about which planet you would like to explore. Which planet have you prepared to choose and why you choose it? The basic characteristics of the planet are, for example, the position and surface size, what has already been found out about the planet, and what you hope to find out when you visit it. The picture shows a general view of outer space of Solar System not specifically referring to a planet. Although Jupiter is mentioned in the picture on the right, but it is highlighted by the four satellites around it, and the focus is not on Jupiter. In this image of Solar System, planets Jupiter and Mars are dominant and the pictures can represent any planet. Therefore, the author believes that the pictures here mainly play a decorative role and are created to adapt the style of the text, as shown in Figure 6.

4.2. The Loose Style of Picture and Text-Arousing Emotion Alienation

Figure 7 shows an illustration belongs to the exercise part of the textbook, and its corresponding text is to go over the following passage guessing the meaning of the unknown words. Listen to Part A once more and fill in the blanks. Write one word for each blank. It can be seen from the instructions of this paragraph that the author hopes to stimulate the listener’s association through the picture, but the subject of the text refers to birds. The text also mentions that the use of oil makes some changes in the feathers of birds, but the picture does not reflect the role of oil. This picture makes the reader feel at a glance that the subject in the picture is forced to execute certain instructions and struggling, which makes the reader feel a tense atmosphere. Therefore, there is a sense of tension in the relationship between the picture and the text. The film does not present a completely irrelevant scene, so the relationship between picture and text is alienated.

4.3. Picture and Text Loose Control Agreement Style

The text corresponding to Figure 8 is that if you meet a foreigner who comes up choose to you talk, what countries might he be from? If a girl in wearing shorts goes into a Muslim house and a man pointing at her shoes and shorts, then what should she do? It can be seen from the text that its main content is foreign-related etiquette, which has a wide range. Looking at the picture again, although the front shows the faces of two Westerners, we cannot be sure whether they belong to foreigners or natives with their backs to the faces of readers, and the handshake can be entered when we meet; it can also be a handshake when reaching a certain agreement and business cooperation. Moreover, there are computers and documents in the picture. At first glance, it looks more like negotiating business, and the scope is significantly narrower than that of foreign etiquette. Therefore, the author believes that the picture has a certain correlation with the text, but its main purpose should be to retain the reader’s attention so that the reader is not tired of boring words and does not have the function of restatement of the text or inducing the reader’s point of view.
Figure 5: Bilingual dual coding model, from Paivio and Desrochers.

Figure 6: Picture and text loose-decoration-matching style.
4.4. The Close Relationship between Picture and Text-Organization-Positioning Style. The corresponding text is from the Atlas; we could see that the Mekong River begins in a glacier on a Tibetan Mountain. It becomes rapids as it passes Yunnan Province. It became slow when it enters to Southeast Asia. At last, the river delta enters to the South China Sea. The text describes to the reader the location of the Mekong River, which originates from the Qinghai Tibet Plateau and the flow of water is slow, cold, and clear. When passing through Yunnan Province, then the flow of water
becomes fast, with Grand Canyon and waterfall. When entering Southeast Asia, the speed slows down and finally enters to South China Sea. The purpose of illustration is to present the Mekong River Basin and specific location to students so that readers can locate their eyes on the map and make it clear to readers at a glance. The illustrations have a strong organizational role and belong to the positioning in the relationship between pictures and texts.

By analyzing the different results of the experiment, it can be seen that the effect of English vocabulary teaching from the perspective of dual-coding theory is improving, and the effect of accompanying graphic memory is increasing. The experimental results are shown in Figure 9.

In Figure 10, the horizontal axis represents the degree of memory and the vertical axis is the number of double pictures and texts. According to the increase of the number of pictures and texts, the degree of memory continues to improve and the difficulty of memory becomes lower, which shows that the better the effect of double combination of pictures and texts, the stronger the degree of memory.

5. Conclusion

Based on the basic connotation of dual-coding theory and illustration of lessons from relevant research results, this paper discusses the application strategies in the future from different aspects. First of all, this article gives attention to the visualization of vocabulary teaching. In the process of language teaching, divergent thinking and image thinking can help students to extend their impression so as to improve their cognitive level. In the process of improving the visualization of vocabulary teaching, students should be helped to associate at the functional level from the image of vocabulary. Secondly, it guides students’ cognitive processing of vocabulary. In the future high school English vocabulary teaching process, we should change the traditional rote teaching methods and constantly strengthen the content of vocabulary teaching and the cognitive processing of vocabulary teaching around the students’ language cognitive characteristics and the application requirements of dual-coding theory. Actively guide students to expand and extend words through the words they know. Thirdly, pay attention to student motivation. Dual-coding theory is an important guiding theory of English vocabulary teaching in senior high school. In the specific process of practice, we should constantly focus on students’ vocabulary cognitive characteristics and improve students’ awareness of active participation. In particular, starting from the goal of English vocabulary teaching in senior high school, we should strengthen the necessary incentive conditions, incentive methods, and the realization of incentive objectives. The experiment of cognitive memory based on dual-coding theory proves that fine processing coding helps vocabulary enter long-term memory. Dual-coding theory plays a very important practical role in English vocabulary teaching. How to further develop the value of dual coding theory and meet the requirements of English vocabulary teaching in the new era is a major topic in the whole academic field. This paper mainly analyzes the basic connotation of dual-coding theory and the ways and methods of its application in English vocabulary teaching in the future. It is hoped that this study can help to promote the improvement of the overall teaching theory and practice of English vocabulary teaching.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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