Dual Coding Theory and Vocabulary Learning: Animation and Word Definition Integration

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Abstract

This study utilizes Paivio's dual coding theory (DCT) as a theoretical framework to investigate the effectiveness of using animation and word definition in enhancing vocabulary learning among Saudi English as a foreign language (EFL) students. The DCT suggests that by simultaneously activating verbal and visual coding systems, learners can facilitate the formation of connections between visual and verbal mental models, as well as prior knowledge, to promote comprehension and meaning construction. The participants were exposed to L2 word definitions accompanied by animations while reading ten hypermediated texts, with the goal of supporting the encoding and learning of their vocabulary. A one-group pretest-posttest design was employed to evaluate the impact of the DCT-based strategy on four dimensions of vocabulary learning, i.e., comprehending the meaning of unfamiliar words based on context, creating new meanings of a word, utilizing words appropriately in diverse contexts, and incorporating new vocabulary by connecting it with prior knowledge across diverse contexts. A vocabulary test comprising of recognition and production questions was administered to the participants before and after the experiment. The results demonstrate that the DCT-based teaching strategy significantly improved the participants' vocabulary scores on the posttest compared to their performance on the pretest, indicating the substantial influence of animation and word definitions on vocabulary learning. These findings contribute to the existing literature by highlighting the potential advantages and effectiveness of incorporating the DCT into vocabulary instruction.

Keywords: Dual coding theory, vocabulary instruction, word definitions, animation.

Introduction

In the contemporary globalized era, proficiency in EFL communication has acquired utmost significance for university students, as it directly impacts their academic and professional trajectories. Among the various strands of language learning, vocabulary development assumes a pivotal role in bolstering both communicative competence and language comprehension within the EFL context. The acknowledgement of vocabulary learning as a crucial element for achieving fluency in EFL is widely acknowledged in the field. University students, in particular, encounter specific challenges in augmenting their vocabulary repertoire due to limited exposure to authentic language input and scarce opportunities for meaningful engagement. Consequently, it becomes imperative to explore pedagogical interventions that hold potential in enhancing the process of vocabulary learning among EFL university students.

One such intervention deserving attention is the DCT, which envisions the incorporation of diverse modalities such as textual, auditory, visual, and pictorial glosses into authentic texts, rendering them more comprehensible to second language (L2) learners and amplifying the vocabulary learning prospects. Introduced by Allan Paivio (e.g., Paivio, 1971, 1986, 1990, 2007, 2008), the DCT has emerged as a prominent theoretical framework in the realm of language acquisition research. The theory posits that the integration of verbal and visual modalities can significantly enhance the encoding and retrieval processes of acquired knowledge. On the premise of this theoretical framework, it is suggested that the human brain engages in distinct processing of visual and verbal stimuli, functioning independently. However, it further contends that these two modalities possess the potential to interact and mutually reinforce each other's impact when blended together (Paivio, 1986). The verbal system is accountable for encoding and processing language-based information, while the non-verbal or visual system takes charge of sensory-based information and imagery. The simultaneous incorporation of both language and non-linguistic information has demonstrated the capacity to augment the learning process and fortify the capacity to retain knowledge. This is achieved by harnessing the strengths of both visual and verbal channels, leading to enhanced cognitive processing and memory retention for learners (Sadoski & Paivio, 2008).

The adaptation of DCT principles to the realm of EFL learning offers a promising avenue for augmenting the efficacy of vocabulary instruction

within university classrooms. In line with DCT tenets, the learning of vocabulary through combined verbal and visual stimuli maximizes learning capacities by stimulating multiple cognitive processes and memory systems (Kam et al, 2020; Plass et al, 2003). Consequently, this study specifically examines the impact of employing animated images and word definitions on vocabulary learning among Saudi EFL university students.

Literature Review

The field of educational technology has undergone significant advancements in recent years, offering educators abundant possibilities to incorporate audiovisual tools and authentic materials within language classrooms. This global progression in educational technology, particularly the integration of multimedia, has substantially altered instructional strategies in the context of teaching and learning EFL. Consequently, both teachers and students have assumed transformed roles, whereby students actively employ technology for communication purposes and engage with information through various cognitive processes such as generation, acquisition, and manipulation. In light of this, teachers bear a crucial responsibility in adopting instructional methodologies that encompass multimedia technologies to enhance learning experiences. These technologies provide opportunities for generative, focused, active, reflective, and collaborative forms of instruction that surpass the limitations posed by traditional teaching resources. Supporting this notion, Wang and Lee (2021) posit that the utilization of multimedia, particularly technology, facilitates effective communication and furnishes students with an abundance of valuable learning prospects.

Additionally, the use of technology serves as an effective means of enhancing instruction by utilizing diverse media, including sound, text, graphics, images (still/motion pictures), and video, to maximize the potential of instruction, promote self-paced learning among students, and efficiently attain the desired learning outcomes. This utilization of various media types, either individually or in combination, aligns with the DCT proposed by Paivio (1971) and further applied to literacy in a plethora of research such as the studies by Kaplan-Rakowski and Loranc-Paszylk (2019), Lee and Lee (2015), Sadoski and Paivio (2001), Yanagisawa (2020), and Yun (2011).

The DCT posits that the retention and retrieval of information are more efficient when it is encoded in both verbal and visual formats. This theory asserts the existence of two distinct and independent systems in human memory and cognition: the verbal system and the visual system. Each system plays a different role and possesses unique attributes and components for storing and processing information. The verbal system primarily handles linguistic details, processing and storing information in the form of words and sentences. On the other hand, the visual system specializes in processing and storing visual representations, including images and other similar depictions. These parallel systems work in tandem, leading to positive effects on recall. Specifically, when both the verbal and visual systems are activated simultaneously, the combination creates an additive effect that enhances memory performance. According to Paivio (1991), dual encoding, where information is represented in both verbal and visual forms such as words and images, results in improved retention and retrieval. This phenomenon can be attributed to the complementary nature of verbal and visual processing in the human cognitive architecture, highlighting the significance of incorporating both modalities for effective learning and memory enhancement.

According to Rieber (2005), the DCT operates at three levels: representational, associative, and referential. Representational processing involves activating verbal or visual representations, while associative processing entails making connections within the verbal or visual systems. Referential processing, on the other hand, involves cross-system connections that integrate new information with existing knowledge. Dual coding in multimedia instruction aligns with referential processing, encoding information in both verbal and visual systems, and increasing retrieval possibilities for effective memory retention. Practically, presenting words as narration and pictures as animation engages learners cognitively, storing words in verbal working memory and images in visual working memory. Establishing meaningful cognitive representations through mental connections and organizing words and images into cause-and-effect chains strengthens learning, further supported by referential connections to prior knowledge (Moreno &Mayer, 1999).

Meanwhile, Moreno and Mayer (1999) cognitive theory of multimedia learning, influenced by Paivio's DCT, has offered valuable insights into crafting effective instructional technology and face-to-face teaching utilizing multimedia. These principles, rooted in a research-informed

understanding of how multimedia facilitates learning, advocate for learner-centered approaches. They span eight major principles for multimedia presentations with animation, emphasizing the use of multiple representations, spatial and temporal contiguity, coherence, modality, redundancy, personalization, and consideration of individual differences (Mayer & Moreno, 2003). The recommended strategies involve presenting explanations using both words and pictures, ensuring narration and animation are presented synchronously and in close proximity, minimizing extraneous information, prioritizing animation and narration over on-screen text, avoiding the combination of animation and narration with printed text, employing a conversational style, and taking into account learners' characteristics such as their level of knowledge and spatial abilities (Yeh & Wang, 2003).

In contemporary multimedia environments, the seamless integration of glosses into electronic texts offers novel opportunities for enhancing learning experiences. The utilization of multimedia glosses, accessible through hyperlinked words, can provide various advantages over traditional printed glosses. Unlike their printed counterparts, electronic glosses are more appealing due to their dynamic nature (Faramarzi et al., 2014). Instead of being imposed on the reader's visual field, electronic glosses remain unintrusive until accessed by the reader.

Moreover, the versatility of multimedia glosses allows for the inclusion of diverse formats beyond mere text, such as images, sound, and videos. This comprehensive integration of different modalities can significantly bolster learners' comprehension, pronunciation, and contextual understanding, surpassing the limitations of traditional materials (Bisson et al., 2015). For instance, learners accessing multimedia glosses with accompanying audio files can engage in auditory reinforcement exercises to refine their pronunciation skills. Similarly, the inclusion of visual data, such as images or videos, can facilitate a deeper understanding of contextual usage. The benefits of multimedia glosses extend beyond their capacity to appeal to learners and accommodate different modalities. They have been lauded for their ability to enhance comprehension, pronunciation, and contextual understanding through their multimodality (Yanguas, 2011). By leveraging Paivio's DCT, multimedia glosses provide a comprehensive learning experience by engaging multiple sensory channels simultaneously.

DCT and Vocabulary Learning

The field of EFL vocabulary instruction often revolves around the introduction of new terms within reading or listening texts. However, this results in lower English language proficiency among students (Sydorenko, 2010; Tragant et al., 2016). Educational technology is viewed as a solution to this issue, transforming traditional teaching methods and promoting the constructivist view of learning. By incorporating multimedia elements, such as pictorial cues and animations, learners can better comprehend, utilize, and integrate new vocabulary, aligning with the principles of DCT and enhancing instructional outcomes (Bisson et al., 2015; Shahrokni, 2009).

Supporters of multimedia instruction argue that verbal material can evoke visual representations and vice versa. Based on previous research, Mayer (2004) proposed recommendations for multimedia learning, including the use of words and pictures, spatial and temporal proximity, and minimizing unnecessary details. Faramarzi et al. (2014) supported the use of visuals in enhancing vocabulary utilization. Sadoski and Paivio (2001) emphasized temporal contiguity to establish connections between verbal and visual representations. Similarly, research indicates that learners who rely solely on auditory methods for vocabulary acquisition tend to achieve lower scores compared to those who incorporate visual aids such as pictures and videos. Visual resources play a vital role in enhancing learners' comprehension of linguistic forms, particularly when animated visuals are utilized.

Mayer (2009) further supports the idea that multimedia learning occurs when students engage with information presented in multiple formats, combining visual animations with verbal narration to facilitate the construction of knowledge. It is noteworthy that verbal material can stimulate the creation of visual representations, while visual material can elicit the formation of verbal representations. Animated tools effectively capture students' attention and enhance word-focused learning through interactive features that engage multiple senses. Furthermore, animations contribute to the fusion of enjoyment and learning, transforming the educational setting into an edutainment environment. Integration of animations in language classrooms also accommodates diverse learning styles, thereby creating a more accessible and enjoyable language learning experience.

Numerous studies have consistently supported the effectiveness of dual coding in vocabulary learning. Tabatabaei and Shams (2011) conducted

an study with high school students, demonstrating that multimedia gloss groups outperformed the control group in vocabulary acquisition and text comprehension, particularly when combining text and picture glosses. Moradan and Vafaei (2016) also found that learners who received a combination of pictorial and textual glosses showed superior vocabulary learning. Additionally, Kassim (2018) conducted a study comparing the effects of animated images and static images on ESL students' vocabulary learning, revealing that the group exposed to animated images retained more target words.

In their study, Ramezanali and Faez (2019) investigated the effectiveness of different modes of gloss presentation, including L2 definition, aural, and video animation, in vocabulary learning and delayed word recollection. The results of their study, based on a control group and three experimental groups, demonstrated that dual glossing modes were generally more effective than single glossing modes, although single glossing also proved to be effective in some instances. Similarly, Nunpaporn and Suwanasilp (2021) developed and implemented a Multimodal Glossing Vocabulary Program (MMGR) to enhance English vocabulary acquisition. Their study, involving a control group and two experimental groups, showed that the MMGR program was more effective than a Textual Glossing Vocabulary Program (TGR) or a control group. Additionally, Teng and Zhang (2021) examined the role of working memory in vocabulary learning through multimedia input. Their study revealed that the Definition + Word information + Video condition had pronounced effects on vocabulary learning and retention, with complex executive working memory and phonological short-term memory playing significant roles. Finally, Wang and Lee (2021) studied the effectiveness of different types of multimedia glosses on vocabulary acquisition and vocabulary comprehension. It was found that glosses with picture and video components led to higher vocabulary gains, while all multimedia glossing presentations improved vocabulary comprehension. Students favored glosses with video and picture components. Overall, these studies highlight the importance of incorporating multimedia elements in vocabulary learning to enhance its effectiveness.

The current study makes a significant contribution by focusing on four crucial dimensions of utilizing the DCT in vocabulary learning. Firstly,

the study emphasizes the importance of comprehending the meaning of unfamiliar words based on context. This is supported by previous research conducted by Hardanti et al. (2015) which suggests that contextualized learning enhances vocabulary acquisition. Secondly, the study explores the creation of new meanings of a word. Cognitive psychologists such as Paivio (1990) argue that the dual coding of verbal and visual information facilitates the creation of multiple associations, thereby enhancing vocabulary retention. Thirdly, the study investigates utilizing words appropriately in diverse contexts. Previous research by Shadiev et al. (2020) indicates that the integration of contextual information leads to more robust memory representations, enabling learners to use words effectively across different situations. Lastly, the study examines the incorporation of new vocabulary by connecting it with prior knowledge across diverse contexts. This is supported by the work of Moreno and Mayer (1999) who found that connecting new vocabulary to existing knowledge improves understanding and retention. By focusing on these four dimensions, this study contributes to the understanding of how the integration the integration of verbal and visual modalities within the DCT enhances vocabulary learning.

Aim of the Study

The study examines the potential benefits of integrating multimedia tools and visual aids in vocabulary instruction for Saudi EFL university students. Through the integration of animation and word definitions, the study intends to develop Saudi university students' ability to comprehend the meaning of unfamiliar words based on context, create new meanings of a word, utilize words appropriately in diverse contexts, and incorporate new vocabulary by connecting it with prior knowledge across diverse contexts. By fulfilling these objectives, this study might provide a research-based framework for the design of effective multimedia instruction in vocabulary learning for Saudi EFL university students.

Questions of the Study

1. What is the impact of the DCT on enhancing Saudi EFL university students' overall learning of vocabulary?

2. How far does the DCT enhance Saudi EFL university students' varied dimensions of vocabulary learning (i.e., comprehending the meaning of unfamiliar words based on context, creating new meanings of a word, utilizing words appropriately in diverse contexts, and incorporating new vocabulary by connecting it with prior knowledge across diverse contexts)?

Hypotheses of the Study

1. There is a statistically significant difference between the mean scores of the participants on the pretest and the posttest in overall learning of vocabulary in favor of the posttest.

2. There are statistically significant differences between the mean scores of the participants on the pretest and the posttest in comprehending the meaning of unfamiliar words based on context in favor of the posttest.

3. There are statistically significant differences between the mean scores of the participants on the pretest and the posttest in creating new meanings of a word in favor of the posttest.

4. There are statistically significant differences between the mean scores of the participants on the pretest and the posttest in utilizing words appropriately in diverse contexts in favor of the posttest.

5. There are statistically significant differences between the mean scores of the participants on the pretest and the posttest in incorporating new vocabulary by connecting it with prior knowledge across diverse contexts in favor of the posttest.

Method and Procedure

This part covers the study design, the participants, the vocabulary pre-posttest, study materials, and the procedure followed throughout the study.

Design of the Study

A one-group pretest-posttest design was employed in the study. The rationale behind adopting the one-group design lies in the specific research focus on the integration of animation and word definition within the framework of DCT to enhance vocabulary learning. By employing a one-group design, the researcher was able to directly examine the participants' performance in vocabulary through a pre-post vocabulary test, measuring their abilities before and after the implementation of the DCT-based strategy. Furthermore, the one-group design was deemed appropriate because the aim of the study is to explore the effectiveness of integrating animation and word definition as a learning strategy, as guided by the principles of DCT. Consequently, having a single experimental group enabled a more focused examination of the effects of the intervention on

vocabulary learning outcomes. Overall, the selected one-group design facilitated a comprehensive assessment of the DCT-based strategy's impact on vocabulary learning, allowing for a detailed understanding of the potential benefits offered by the integration of animation and word definition within the context of the DCT.

Participants

The study comprised of a group of 42 male EFL students majoring in English at the College of Languages and Translation, Imam Mohammad Ibn Saud Islamic University (IMSIU), during the first semester of the academic year 2020-2021. These participants, with a median age of 20.1 years, constituted the experimental group. Assessment of vocabulary development was accomplished through the vocabulary pre-posttest, which was administered prior to and following the experiment.

Teaching strategy

The participants followed a schedule of two 50-minute sessions per week over a period of 13 weeks, resulting in a total of 26 instructional hours. The study was carried out in the language laboratory throughout the scheduled lectures of the participants. First, the researcher explained the aim and procedure of the study and asked the participants to sign the informed consent form. Then followed by the next phase, which took place in the language laboratory, the participants read the computerized texts that incorporate animation and word definitions.

The researcher utilized the ten designated passages sourced from the prescribed reading textbook, namely *Reading Explorer 3* (Bohlke & Douglas, 2019). These passages underwent a systematic process of conversion into electronic texts through a series of procedural steps. These steps encompassed the insertion of word definitions and animated images pertaining to the target words, the formulation of recognition and production questions, the creation of the aforementioned electronic texts, and the subsequent integration of multimedia glosses within the texts. Notably, all glossed words were prominently marked in red and hyperlinked. Consequently, when the participants interacted with these words through clicking, a window would instantaneously appear, facilitating the display of an animated image that would provide clarity and elucidate the intended meaning of the respective word. Moreover, the participants were also afforded the opportunity to access additional linguistic content in the form of synonyms, antonyms, and exemplar sentences related to the glossed words. The recognition and production questions were purposely structured

to incorporate an interactive component. This interactive attribute facilitated the expeditious provision of feedback pertaining to the chosen response. In cases where the initial selection was incorrect, the participants were subsequently prompted to make an additional attempt and so on.

The teaching strategy employed in this study involved a sequential approach, complemented by a range of tasks and activities. This strategy entailed presenting words in a reading format and images in an animated form accompanied with word definitions. By adopting this strategy, the participants were actively engaged in cognitive processes as they directed their attention to pertinent segments of the reading, subsequently retaining the verbal information in their working memory. Similarly, the participants directed their attention to the animations, effectively retaining the visual content in their visual working memory. Subsequently, the participants established mental connections that facilitated the organization of the words into a cause-and-effect framework. In this process, referential connections were established between the visual and verbal mental models, in addition to connecting these mental models with prior knowledge (Mayer & Moreno, 2003). As a result, meaningful mental representations were constructed, aligning with the tenets of cognitive constructivism (Kirschner et al., 2006).

The vocabulary pre-posttest

Designed to ascertain the effectiveness of animation and word definition integration, the vocabulary test was employed both as a pre-posttest to measure students' vocabulary learning. This procedure took place prior to the commencement of the study (i.e., week 1) and after its completion (i.e., week 15) during the first semester of the academic year 2020-2021. The vocabulary test was constructed based on ten reading passages extracted from Bohlke and Douglas' *Reading Explorer 3* (2019). To ensure consistency, the same vocabulary test was administered as a post-test at the culmination of the study.

This assessment encompassed a combination of recognition and production questions. The production tasks consisted of 20 items, demanding students to provide L2 meaning definitions or synonyms for the provided words. Similarly, the recognition tasks entailed 20 multiple-choice questions, wherein the participants were required to select the correct word from four distractors based on the provided definition in the stem. Notably, the vocabulary production tasks were administered prior to the recognition

questions to allow for a well-sequenced and comprehensive analysis of the participants' vocabulary proficiency.

In order to assess the content validity of the test, it was administered to six EFL professors who were tasked with evaluating each item based on its appropriateness in relation to the content and the level of comprehension it measured. In addition, they were requested to assess the overall test based on three criteria: (a) accuracy, (b) quantity of items, and (c) appropriateness of the test questions for level-two university students. The test demonstrated a high degree of validity, as it assessed the intended construct.

The test reliability was assessed using the test-retest method. The test was taken by a group of 26 students who were not involved in the main study. The test was administered again to the same students after a period of two weeks. The correlation coefficient was computed for the participants' test scores on the two test administrations. Subsequently, the Cronbach's alpha coefficient was computed and yielded a value of 0.83, indicating a relatively high level of reliability. Hence, the test was deemed reliable for the purpose of the present study.

Results of the Study

The results of this study are presented by relating them to the study hypotheses. The first hypothesis of the study posited that there would be a statistically significant difference between the mean scores of the participants on the pretest and the posttest, indicating an improvement in overall vocabulary learning. Therefore, the researcher employed a t-test for paired samples to compare the mean scores of the participants on the vocabulary pre-posttest.

Table 1

Pretest vs posttest in the overall scores of the experimental group's learning of vocabulary

Group	N	M	SD	DF	t-value	Sig. level	Effect size
Pretest	42	14.17	3.88	41	31.26	0.01	9.77
Posttest	42	32.12	2.52	41			Very large

The results in Table 1 showed a t-value of 31.26, providing evidence to support the first hypothesis. The statistically significant difference in favor of the posttest scores indicated that the DCT-based strategy had a positive impact on the overall vocabulary performance of the experimental group. Remarkably, the effect size value of 9.77 indicated a substantial effect of the intervention in enhancing the participants' performance on the posttest compared to their performance on the pretest.

Continuing with the second hypothesis, it aimed to determine whether there were statistically significant differences between the mean scores of the participants on the pretest and the posttest in comprehending the meaning of unfamiliar words based on context. Similar to the first hypothesis, the participants' mean scores on the pre-posttest were compared using the t-test for paired samples.

Table 2

Pretest vs posttest results on the dimension of comprehending the meaning of unfamiliar words based on context

Dimension	Test	N	M	SD	DF	t-value	Sig. level	Effect size
Comprehending the meaning of unfamiliar words based on context	Pretest	42	3.82	1.28	41	16.41	0.01	5.12
	Posttest	42	6.94	0.53	41			Large

Table 2 provides significant evidence denoting a substantial difference between the mean scores of the participants on the vocabulary pre-posttest in relation to their ability to comprehend the meaning of unfamiliar words through context. This difference is in favor of the posttest scores, as evidenced by the statistically significant calculated t-value of 16.41. Moreover, the effect size observed was 5.12, indicating a large effect. These findings signify that the participants exhibited notable improvement in comprehending the meaning of unfamiliar words based on context in the posttest as compared to their performance in the pretest. Consequently, it can be inferred that the implementation of the DCT-based strategy effectively enhanced the participants' capacity for contextual word comprehension, thereby leading to the acceptance of the second hypothesis.

In evaluating the third hypothesis, which postulated that there would be a significant difference between the mean scores of the participants on the pretest and the posttest concerning the dimension of creating new meanings of a word, the researcher utilized a paired samples t-test as presented in Table 3.

Table 3

Pretest vs posttest results on the dimension of creating new meanings of a word

Dimension	Test	N	M	SD	DF	t-value	Sig. level	Effect size
Creating new meanings of a word	t		5.25	1.57	41	29.39	0.01	9.16
	st		13.03	1.29	41			Very Large

Table 3 shows statistically significant differences in the mean scores obtained by the participants on the pre-posttest in terms of their ability to create new meanings of a word. This result is supported by the calculated t-value of 29.39. In addition, the effect size of 9.16 suggests a substantial impact, given its classification as a very large effect size. Consequently, the implementation of the DCT-based strategy proved successful in fostering the participants' ability to create new meanings of words.

Moving on to hypothesis four, which postulated the existence of statistically significant differences between the participants' mean scores on the vocabulary pre-posttest in the dimension of utilizing words appropriately in diverse contexts. Employing the t-test for paired samples, the researcher assessed the significance of differences, and the results are detailed in Table 4.

Table 4

Pretest vs posttest results on the dimension of utilizing words appropriately in diverse contexts

Dimension	Test	N	M	SD	DF	t-value	Sig. level	Effect size
Utilizing words appropriately in diverse contexts	t		2.61	0.93	41	20.10	0.01	6.27
	st		6.24	0.76	41			Very Large

Table 4 reveals statistically significant differences at a level of 0.01 between the participants' mean scores in the pre-posttest in relation to the dimension of effectively utilizing words in diverse contexts. It is evident that the posttest scores exhibit a more substantial results, as indicated by the t-value of 20.10. Additionally, the effect size for this dimension measures 6.27, indicating a significant impact. This implies that the participants made notable progress in their ability to appropriately employ words in diverse contexts. Consequently, it can be concluded that the implementation of the DCT-based strategy effectively enhanced the participants' proficiency in utilizing words suitably across a range of contexts. As a result, the fourth hypothesis is affirmed.

The fifth hypothesis posited the existence of a statistically significant distinction between the participants' mean scores in the vocabulary pre-posttest regarding their incorporation of new vocabulary by connecting it with prior knowledge across diverse contexts.

Table 5

Pretest vs posttest results on the dimension of incorporating new vocabulary by connecting it with prior knowledge across diverse contexts

Dimension	Test	N	M	SD	DF	t-value	Sig. level	Effect size
Incorporating new vocabulary by connecting it with prior knowledge	t		2.49	0.73	41	26.62	0.01	8.32
			5.92	0.54	41			Very Large

Table 5 shows significant statistical differences in the participants' mean scores on the vocabulary pre-posttest. These differences are related to the dimension of incorporating new vocabulary by connecting it with prior knowledge across diverse contexts. The posttest scores clearly demonstrate significant results, as evidenced by the t-value of 26.62. Furthermore, the magnitude of the effect for this particular aspect is 8.32, signifying a significant impact. This indicates that the participants demonstrated significant improvement in their ability to effectively utilize words in various situations. Therefore, it can be inferred that the application of the DCT-based strategy successfully improved the participants' ability to integrate new vocabulary by relating it to their existing knowledge in various situations. Consequently, the fifth hypothesis is confirmed.

Overall, the results conclusively addressed the two research questions pursued in this study. Initially, the results established the effectiveness of implementing a DCT-based teaching strategy in augmenting vocabulary learning among Saudi EFL university students. The results provided robust support for this first research question, demonstrating that the utilization of the DCT-based strategy significantly enhanced participants' overall vocabulary learning. The substantial difference in mean scores between the pretest and posttest administration served as empirical evidence of the participants' substantial improvement in vocabulary learning. Furthermore, the DCT-based strategy proved effective in enhancing the participants' performance across the multifaceted dimensions of vocabulary learning.

Discussion

The study yielded noteworthy findings regarding the impact of integrating animation and word definitions on vocabulary learning. The integration the DCT into vocabulary learning has yielded significant results, establishing it as a structured and cognitively sound framework. The DCT employs three dynamic associative processes, namely the representational, associative, and referential connections, to facilitate knowledge acquisition (Moreno & Mayer; 1999 Rieber, 2005). In this study, the focus was primarily directed towards the referential connections, which fostered the establishment of links between verbal and imagery information. In addition, the integration of word definitions and animations in vocabulary learning served as a means to construct meaningful connections between newly acquired representations and previously learned ones. This deliberate integration provided a structured framework within which the participants engaged in interactive and purposeful communication. The findings derived from this study corroborate the findings of prior research, notably the works Boers et al. (2017), Muñoz et al. (2017), and Wang and Lee (2021).

Furthermore, it is worth noting that the presence of glosses in dual modes, specifically through L2 definitions and animation, was found to significantly enhance vocabulary learning among students. This finding aligns with prior research which has consistently shown that dual glossing modes outperform single glossing modes (e.g., Lin & Tseng, 2012; Peters, 2019; Yanagisawa, 2020). For example, in Lin and Tseng's study, it was found that learning vocabulary words with textual definitions and some visual aids constructed stronger meaning representations than learning vocabulary words in isolation. A plausible explanation for these findings can be attributed to the cognitive-affective theory of learning with media, particularly the modality effect. The modality effect suggests that when information is presented in a mixed-mode format that combines visual and auditory elements, it leads to more effective learning compared to using a single-mode format that only features either visual or auditory elements. When learners are exposed to dual glossing modes, they are able to encode the glossed vocabulary in both visual and verbal formats and process it through both verbal and visual channels (Ramezanali et al., 2020). This reduces cognitive load by distributing it between the visual and verbal channels.

An analysis of the teaching strategy employed in the study is provided in relation to the performance of the participants on the four

dimensions of vocabulary learning that were developed throughout the implementation of the strategy. Comprehending the meaning of unfamiliar words based on context was the first dimension of the participants' vocabulary learning experience in this study. Throughout the collaborative activities, the participants actively engaged with the textual context and focused on the contextual significance of individual words. They were then tasked with rephrasing the meaning of the animated words based on the clues and context provided. The results showed that a significant proportion of the participants demonstrated precise and suitable comprehension of the words.

During the teaching stage, the participants were presented with words and instructed to observe the accompanying animations. They were then asked to select the most appropriate and precise definition for each bold word. In cases where some participants initially made errors in determining the accurate meaning, their peers intervened by providing explanations supported by textual evidence. This collaborative problem-solving approach helped to improve their understanding and accuracy in defining the words. One of the post-teaching activities conducted to evaluate the development of participants in this dimension involved providing them with sentences containing bold words extracted from the text and asking them to provide a definition for each word using a list of word definitions. The majority of the participants effectively delivered accurate responses, successfully matching the words with their corresponding definitions. This indicates that their comprehension of the unfamiliar words improved over time. These findings align with previous research studies that support the efficacy of utilizing contextual cues in vocabulary learning. According to Greenwood and Flanigan (2007), incorporating contextual information in vocabulary instruction enhances students' word understanding and retention. Similarly, Zarfsaz and Yeganehpour (2021) found that providing explicit cues from the context aids in the comprehension and acquisition of new vocabulary.

Next, the participants' ability to generate new meanings of words significantly improved as a result of the strategy activities as well. Initially, in the vocabulary pre-test, most participants struggled to differentiate the different meanings of a word. However, after engaging in the vocabulary activities that used animated words and visual vocabulary activities, the participants were able to effectively explain the meanings of words. An

activity involved the participants reading sentences and focusing on the bold words. They were then asked to compare these bold words with words used in sentences from a text following a box that included the bold words. During this activity, the participants were required to explain any differences in word meanings and discuss their answers with a partner.

The use of animated contextualized words greatly aided the participants in correctly identifying the various meanings of the same word. Additionally, it was observed that some participants were able to recall different meanings for a word from previous lessons, even when not explicitly prompted to do so. This indicated that the participants developed the ability to apply their vocabulary learning to new situations. These findings are in line with previous studies that have also demonstrated the effectiveness of animated representations and visual vocabulary activities in helping learners generate new meanings of words (e.g., Cain et al., 2003; Graves, 2006).

The Participants showed significant improvement in their ability to use words appropriately in diverse contexts throughout the implementation of the teaching strategy, which pertains to the third dimension of vocabulary learning. For instance, a pre-teaching activity was conducted wherein the participants were presented with a text accompanied by animations and word definitions. Subsequently, they were required to articulate their understanding of the text using their own words. The participants exhibited the ability to effectively employ precise words and expressions that they had encountered in the animated texts. Moreover, they demonstrated a heightened proficiency in utilizing the language in a more contextually accurate manner. This activity enabled the participants to not only expand their vocabulary, but also to deepen their understanding of how words and phrases can be appropriately applied in real-life situations. Their ability to draw connections between the animated texts and their own experiences showcased their enhanced competence in utilizing words appropriately in diverse contexts.

There findings are supported by Mayer (2003) who found that when learners are presented with animations and accompanying word cues, they are more likely to comprehend and retain the meaning of words and use these words appropriately in diverse contexts. This supports the idea that animated texts can effectively contribute to vocabulary learning by providing learners with contextualized examples of word usage. Furthermore, studies by Ranalli and Palmer (2017) and Kang and Plass

(2015) have shown that animated texts can enhance learners' ability to apply words in different contexts. These findings highlight the efficacy of incorporating animated texts in vocabulary learning strategies that aim to improve learners' proficiency in utilizing words appropriately across diverse situations.

Lastly, participants showed a notable ability to integrate new vocabulary by utilizing their prior knowledge, which is consistent with earlier studies (e.g., Stahl et al., 1991; Puimège & Peters, 2019). This capacity for connection-building between novel words and the participants' pre-existing linguistic repertoire was prominently displayed throughout the intervention. The participants seamlessly integrated the vocabulary acquired from the animated texts into contexts that diverged from those presented within the texts themselves.

The fostering of the participants' ability to integrate unfamiliar words by linking them to prior knowledge was carried out during all phases of the teaching strategy. For example, a post-teaching activity was conducted to engage the participants to articulate their prior knowledge, employing the words they had learners during the reading portions of the animated texts. Notably, the participants' vocabulary underwent further development as the animated texts facilitated the evocation of background words through real-life examples. This further supports the effectiveness of connecting new vocabulary with prior knowledge in vocabulary learning (Montero, 2020; Stahl et al., 1991).

This improvement indicates that connecting new vocabulary with prior knowledge contributes to vocabulary learning (Hiebert & Kamil, 2005). Additionally, the participants' heightened interest in the thematic content of the animated texts fostered the deployment of real-life instances as anchors for the newly acquired vocabulary. This utilization of vocabulary gleaned from the animations and word definitions resulted in a heightened level of lexical precision, highlighting the significance of connecting new vocabulary with prior knowledge in vocabulary learning (Ramezanali et al. 2020; Yanagisawa et., 2020).

Conclusions and Implications

These study findings contribute to the existing literature by providing empirical evidence that the DCT provides a structured and cognitively sound framework for promoting effective vocabulary learning.

Considering this constructive influence of the DCT-based strategy in the domain of vocabulary learning, there exists a proclivity to regard the incorporation of animations and word definitions as a form of interactive intervention that is contextually grounded and fashioned with the learner's needs in mind, thereby serving as an effective means to enhance L2 vocabulary learning. Commensurate with such a conclusion, the utilization of the DCT-based strategy offers a plethora of pedagogical and educational benefits, such as the accommodation of students' preferred modes of vocabulary learning and their individual learning styles. This has significant implications for educators and curriculum developers. By utilizing the DCT-based strategy, educators can create interactive and engaging learning environments that promote active participation and stimulate the use of diverse senses.

One of the key implications of this study is the importance of considering context in vocabulary learning. The DCT strategy enables students to comprehend word meanings based on the surrounding context, thereby enhancing their ability to extract meaning from real-life situations. This skill is particularly valuable as it helps students develop a deeper understanding of word usage beyond rote memorization.

Furthermore, the DCT-based strategy of vocabulary instruction fosters the creation of new word meanings. By connecting verbal and visual representations, students are encouraged to generate their own interpretations and associations with vocabulary. This not only enhances their engagement with the vocabulary activities but also supports a more personalized and meaningful learning experience.

Another noteworthy implication of this study is the development of appropriate word usage in diverse contexts. The integration of animation and word definitions within the DCT-based strategy enables students to visualize and internalize different scenarios where specific vocabulary words can be applied. This enhances their ability to use words accurately and effectively in various communicative situations, thus advancing their language proficiency.

Moreover, the DCT facilitates the integration of newly acquired vocabulary into existing knowledge. By creating connections between verbal and visual representations, learners are able to relate and anchor the new vocabulary within their existing knowledge frameworks. This integration promotes a deeper understanding of words and aids in their long-term retention.

Furthermore, the study opens avenues for further research on vocabulary instruction and the integration of instructional strategies based on the DCT. Future studies could explore the application of this theory with different learner populations and in various educational contexts. Additionally, research into the long-term effects of the DCT-based strategies on vocabulary retention and transfer of learning would provide valuable insights. These avenues for further investigation highlight the benefits of the DCT-based strategy in enhancing various dimensions of vocabulary learning and provide a basis for further research and instructional development in the field of vocabulary instruction.

نظرية الترميز المزدوج وتعلم المفردات: دمج الصور المتحركة وتعريفات الكلمات

رفيق أحمد عبد المعطي محمد

المستخلص

يستخدم البحث نظرية التشفير المزدوج لبايفيو كإطار نظري لدراسة مدى فعالية استخدام الصور المتحركة وتعريفات الكلمات في تعزيز تعلم المفردات اللغوية بين الطلاب السعوديين الدراسيين للغة الإنجليزية كلغة أجنبية. تركز نظرية التشفير المزدوج على أهمية تفعيل أنظمة الترميز اللفظي والمرئي في وقت واحد مما يمكن الطلاب من تكوين الروابط بين النماذج المعرفية البصرية واللفظية، وكذلك المعرفة المسبقة، لتعزيز الفهم وبناء المعنى. وقام الطلاب بدراسة تعريفات الكلمات باللغة الإنجليزية مصحوبة بصور متحركة لتلك الكلمات أثناء قراءة عشرة نصوص قرائية بهدف دعم الترميز اللفظي والمرئي للمفردات اللغوية. وتم استخدام تصميم الاختبار القبلي والبعدي المكون من مجموعة واحدة لتقييم تأثير الاستراتيجية القائمة على نظرية التشفير المزدوج على أربعة أبعاد لتعلم المفردات اللغوية، وهي فهم معنى الكلمات غير المألوفة بناءً على السياق، وتكوين معاني جديدة للكلمات، واستخدام الكلمات بشكل مناسب في سياقات متنوعة، وأخيراً دمج مفردات جديدة من خلال ربطها بالمعرفة المسبقة عبر سياقات متنوعة. وتم إجراء اختبار مفردات يتكون من أسئلة التعرف والإنتاج على الطلاب قبل وبعد التجربة. وأظهرت النتائج أن استراتيجية التدريس المبنية على نظرية التشفير المزدوج قد حسنت بشكل ملحوظ درجات المفردات اللغوية للطلاب في الاختبار البعدي مقارنة بأدائهم في الاختبار القبلي، مما يشير إلى التأثير الكبير للصور المتحركة وتعريفات الكلمات على تعلم المفردات لديهم، وتساهم هذه النتائج في الأدبيات الموجودة من خلال تسليط الضوء على المزايا والفعالية المحتملة لدمج نظرية التشفير المزدوج في تعليم المفردات اللغوية.

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