Split-Attention effect and learner expertise in Reading Comprehension with Vocabulary Definitions: A case of English as a foreign language

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Abstract: Cognitive load theory has assisted researchers to recognize cognitive effects in reading comprehension that can lead to improvements in reading skills. The aim of this paper is to analyse the split-attention effect in reading English as a foreign language (EFL) with vocabulary definitions. Two experiments were conducted to examine the split-attention effect of cognitive load management using vocabulary definitions in reading texts for EFL students with different levels of expertise. Experiment 1 found that vocabulary definitions integrated within a text (integrated format) improved mainstream EFL students' comprehension (high-level processing) whereas a separate vocabulary list (separated format) improved vocabulary learning (low-level processing).The efficiency of instruction depends partly on its ability to manage cognitive load associated with the learning task. An identical instructional format may enhance learning process by decreasing extraneous cognitive load but may interfere with learning process through split-attention effect depending on learner expertise.

Keywords---Cognitive load theory, reading comprehension, split attention effect

I. INTRODUCTION

Cognitive Load Theory

Cognitive load theory (Chandler & Sweller, 1996) proposes that conventional instructional procedures are insufficient because they require learners to engage in unnecessary cognitive activities that cause a heavy working memory load. Working memory is associated with consciousness and it relates to the way people direct their own attention to think or to process information. Miller (1956) indicates that the biggest limitation of working memory is the capacity to deal with no more than about seven elements of information simultaneously (Miller, 1956). Humans are aware of working memory and can supervise its contents (Sweller, 2004). People use working memory for processing

information by organizing, contrasting and comparing elements, so they can manage only two or three items of information at the same time (Sweller, 2004). Too many elements may strain the working memory and reduce the effectiveness of processing (Kalyuga, Chandler, Sweller, 1999). Thus, working memory is considered as the memory system having the role of holding and manipulating information. In reading comprehension, working memory is limited, so if unnecessary items of information are required to process reading material it may strain working memory and decrease learning (Sweller, 1999; Sweller, Chandler, 1994).

In contrast, long term memory is unlimited (Sweller, Chandler, 1994). Long-term memory refers to our immense body of knowledge and skills. For instance, in reading comprehension, vocabulary, structures, and everything people know are kept in long-term memory. Long-term memory has no known limits in its capacity to store information in a relatively permanent form and no one is directly aware of their long-term memory until some of its contents and functioning are brought into working memory (Kirschner, 2002). Sweller (2004) indicates that while long-term memory is a passive information store, it is a critical component of all cognitive activities.

Obviously, researchers have paid attention to the cognitive and instructional processes that occur when two separate source of information are presented that must be mentally integrated, referred to as the split-attention effect (Yeung, Jin, Sweller, 1997). Cognitive load theory calls the unnecessary memory load caused by the split attention effect extraneous load (Sweller, 1999). To overcome a split-attention effect, a physically integrated format is a good way to decrease extraneous load and to increase effectiveness of instructions (Sweller, 1999)..

With regards to the split-attention effect in reading comprehension, Leahy & Sweller (2004) noted that learners needed to “split” attention and mentally integrated multiple sources of information in a text for understanding to occur. For example, they are two or more related sources of information (e.g., text and diagram), the instruction may require learners to integrate corresponding (verbal and pictorial) information to construct a relevant schema and achieve understanding. The process of information integration may place an unnecessary strain on limited working memory (Kalyuga, Chandler, & Sweller, 1999). Yeung (1996) examines the split attention effect in reading with explanatory notes. In the integrated format, the reader refers directly to the meaning of possibly new words, thus the cognitive load should be lower (Yeung, 1996).

Sweller (1993, 1994) firstly indicated the effect of explanatory notes or vocabulary definitions in the form of vocabulary notes. Their effects may be shown using cognitive load theory (Sweller, 1993, 1994). Yeung, Jin, and Sweller (1997) explained that using a separate glossary of vocabulary helps the learners to acquire word meaning. However, as Yeung el al. (1997) confirmed that their meanings must be used for understanding the text, the process becomes more complex. Given a separate glossary, when learners encounter an unfamiliar word, they need to look up the word in the dictionary, and then try to incorporate the word meaning into the text (Yeung et al., 1997). This process may impose a high cognitive load, referred to as split attention effect (Yeung et al. 1997).

According to Reinking & Richman (1990), explanatory notes can be given within a text and directly adjacent to the target word, and Reinking & Richman (1990) considered that explanatory notes in the integrated format the learners has direct access to the meanings of unfamiliar words therefore the cognitive load in working memory should be consider lowered. Reinking & Richman (1990) explained that physically placing word meanings close to the target words has also been found to enhance comprehension.

However, in terms of high and low- ability readers, while low- ability readers use an integrated format of explanatory notes, they use more mental resources in comprehension because of decreasing split attention (Nicholson, 1991). In contrast, high-ablity readers benefits from the integrated format.

The following experiment aimed to investigate the differences between a separated and integrated formats in explanatory notes. The separated format included the reading text with explanatory notes placed at the end of the text. The integrated format included the explanatory notes integrated physically into relevant paragraphs of the text.

II. EXPERIMENT

Participants

The 152 participants included 76 mainstream EFL students learning in the faculty of foreign languages and 76 non – mainstream EFL students learning in the same faculty, Ho Chi Minh City Open University. The participants were divided into two groups: 76 participants from the mainstream EFL group and 76 participants from the non- mainstream EFL group.

Materials

The experiment consists of two different passages that use English for Geography and History. The first passage included a reading text in English for History, titled "Britain in the 18th century" extracted from the book "*Britain: the country and its people: An introduction for learners of English*" (J. O'Driscoll, 2003), Oxford Publisher, page 24-25. The text had 364 words.

The second passage included a reading text in English for Geography, titled "*Earthquake*" extracted from the textbook "*A course of Basic Scientific and technical English*" (Nguyen Thi Tuyet, 1995), published by HCMC University of Technical Education Publisher, page 38-39. The text consisted of 286 words.

Procedure

Both mainstream EFL and non-mainstream EFL groups were randomly allocated to one of the two texts, history and geography texts and one of the two versions of vocabulary definitions within the texts (separated and integrated versions). Each participant only read and answered 10 related questions of one passage. In the mainstream EFL group, 19 students read the separated version of the geography text, 19 students read the integrated version of geography text, 19 students read the separated version of the history text, and 19 students read the integrated version of the history text. Similarly, the non-mainstream EFL group were divided into the same four subgroups. (see Table 1)

TABLE 1

Experimental design in the Experiment

Group	Text	Version/ Format	N
Mainstream EFL group	Geography	Integrated	19
		Separated	19
	History	Integrated	19
		Separated	19
		Total	76
Non – mainstream EFL group	Geography	Integrated	19
		Separated	19
	History	Integrated	19
		Separated	19
		Total	76
TOTAL			152

There were 10 test questions. Participants were asked to answer the questions in 20 minutes (2 minutes/ per question). Participants were informed beforehand that they would have a total of 20 minutes. During the test, participants could use the text to answer the questions. A clock was used to indicate the time remaining.

Scoring

For the 10 questions, one mark was given for a correct answer and a score of “0” was given for an incorrect answer. An incorrect answer included wrong answers or lack of key words for a correct answer.

III. RESULTS

ANOVAs were performed including between subject variables of the expertise groups (mainstream EFL and non mainstream EFL students), texts (geography and history texts), and versions (separated and integrated versions).

The 0.05 significance level is used throughout this Experiment.

Table 2 showed the mean scores and standard deviations of the correct questions.

TABLE 2.

Means and Standard deviations of scores (both groups)

Group	Text	Version	Mean	Std	N
Non-mainstream EFL group	Geography text	Integrated	4.6	.82	19
		Separated	7.0	1.1	19
	History text	Integrated	2.7	.93	19
		Separated	5.0	1.2	19
	Total		4.8	1.8	76
Mainstream EFL group	Geography text	Integrated	8.7	.78	19
		Separated	6.7	1.3	19
	History text	Integrated	5.9	1.1	19
		Separated	2.5	1.2	19
	Total		6.0	2.5	76
Total	Geography text	Integrated	6.7	2.2	38
		Separated	6.8	1.2	38
	History text	Integrated	4.3	1.9	38
		Separated	3.7	1.7	38
	Total		5,4	2.2	152

There was a significant difference between the two groups (Non-mainstream EFL students and mainstream EFL students groups) $F(1,148) = 14.6$, $MSE = 3.31$, $p < .001$, partial Eta squared = .090. There was no significant difference between the two versions, $F(1,148) = .512$, $MSE = 3.2$. $p = .475$, partial Eta squared = .003. There was a significant interaction between students' groups (non- mainstream EFL and mainstream EFL) and the two versions (integrated and separated) $F(1, 148) = 36.8$, $MSE = 3.31$, $p < .001$, partial Eta squared = .332. Following the significant interaction, simple effects tests demonstrated a significant difference between the two versions for the non-mainstream EFL students caused by a significantly higher mean scores of the separated version than the integrated version $F(1,148) = 30.74$, $MSE = 3.31$, $p < .001$, partial Eta squared = .172, and for the mainstream EFL students caused by a significantly better mean scores of the integrated version than the separated version $F(1,148) = 42.9$, $MSE = 3.31$, $p < .001$, partial Eta squared = .225.

IV. Discussion

The results of the Experiment showed that for the subject areas, English for history and geography, non-mainstream EFL students were not familiar with both texts as low-level readers or novices, however, mainstream EFL students were more familiar with both texts, as high-level readers or experts. The reason was that mainstream EFL students had better background schemas from the learning process in the school curriculum. The results confirmed Lundeberg's study (1987) that readers who had better background knowledge used more effective reading strategies (Lundeberg, 1987).

The results of the Experiment also showed that the integrated version of explanatory notes was beneficial to mainstream EFL students whereas the separated version of explanatory notes was more advantageous to non-mainstream EFL students.

The results obtained from the Experiment demonstrated that non-mainstream EFL students may an increased cognitive load in reading and comprehending the integrated version of explanatory notes in both texts, because the integrated version of both texts frustrated their reading comprehension process, as a result, non-mainstream EFL students were not able to activate the link between the content of the text and background knowledge (Gasparinatou, Tsaganou, & Grigoriadou, 2007). The separated version of the both texts with embedded the meanings of words was beneficial to non-mainstream EFL students, because the separated version added more information as meanings of words which helped non-mainstream EFL students to reduce extraneous cognitive load and to fill the gap between background knowledge and content. However, the integrated version of both texts was optimal for mainstream EFL readers due to decreasing extraneous cognitive load. The additional information of the separated version was redundant and so increased extraneous cognitive load

V. CONCLUSION

The study suggests that extraneous cognitive load can be reduced by using an appropriate format in reading texts with explanatory notes, because providing a split attention format imposes a heavy extraneous cognitive load that interferes with reading comprehension. In other words, integrated format assists high level learners to construct the necessary relevant schemas in reading comprehension and to facilitate the reading process. For EFL/ESL learners, the split attention format is a barrier to comprehending texts. To improve learners' reading comprehension with explanatory notes, it may be necessary to replace split attention instructions with integrated ones.

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