EXPERTISE REVERSAL EFFECT ON READING COMPREHENSION: A CASE OF ENGLISH FOR SPECIFIC PURPOSES (ESP)

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ABSTRACT

Cognitive Load Theory assists researchers in designing instructional procedures that can lead to enhancement of reading skills. This paper aims to examine cognitive load effect as expertise reversal effect on reading comprehension of English for Specific Purposes (ESP). An experiment was designed to investigate whether the expertise reversal effect can be applied to reading comprehension of ESP. The implications of the experiment findings can be used in teaching and learning ESP reading comprehension. The findings will help instructors design more appropriate reading comprehension instructions with alternative versions to integrate different domains such as English for Geography and Mathematics effectively and to test the expertise reversal effect on reading comprehension.

Keywords: Cognitive Load Theory; Expertise reversal effect.

1. Introduction

Cognitive Load Theory (CLT) has developed since the 1980s and attracted many researchers all over the world. CLT is concerned with the limitation of working memory. According to CLT, reading comprehension is defined as a constraint of a limited working memory (Eskey and Grabe, 1988). It will be more difficult for learners if working memory goes beyond its limitations (Goldman, Varma and Cote, 1996). Another difficulty for reading comprehension is the various levels of readers. According to Daneman and Capenter (1983) and Perfetti (1985), low level readers who do not have enough automation of schemas in reading comprehension may generate increased cognitive load. Obviously, differences between high level readers (experts) and low level readers (novices) are explained by using levels of expertise (Chi, Feltovich and Glasser, 1981). There are several instructional effects generated by CLT as the expertise reversal effect when instructions useful for novices may be unhelpful for more expert readers (Kalyuga, Ayres, Chandler and Sweller, 2007). The Expertise Reversal Effect is examined not only in natural sciences but also in well-structured domains like literacy texts (Kalyuga and Renkl, 2010) and biology texts (McNamara, Kintsch, Songer, 1996). The results of McNamara et al.'s (1996) experiments showed that novices would benefit from information added to original instructional text while experts were beneficial from original instructional text (McNamara et al., ibid). Oksa, et al. (2010) used Shakespearean text to differentiate instructional effectiveness and found that it was difficult for novices to comprehend the text, which used a lot of sophisticated Elizabethan English language.

McNamara et al. (ibid) investigated the effect of text cohesion on readers' comprehension. The results demonstrated that low level readers benefited more from high-cohesive texts whereas high level readers benefited more from low-cohesive texts. This is because high-cohesive texts employed many anaphoric referents, sentence connectives, background information, meaningful headings and paragraphs while low cohesive texts do not contain so much structuring information (Tubingen, 2011).

McNamara et al. (ibid) clarified that low-cohesive text required high level readers to engage in compensatory processing to infer unstated relations in the texts as germane possessing, while high cohesive text seduce high level readers to more passing processing instead of activating relevant prior knowledge of their own. In an effort to support the germane cognitive load explanation, O'Reilly and McNamara (2007) did a study about its effect on reading comprehension and found that learners with high prior knowledge and low reading skills did not benefit from high cohesive texts while skilled learners with high knowledge and reading skills would benefit from high cohesive texts. On explain their findings, O'Reilly and McNamara (ibid) considered that good reading skills assist high knowledge learners in involving in germane cognitive load processing. Kalyuga et al. (2007) explained that high knowledge learners, as skilled readers, know how to apply active processing strategies into well guided text instructions. McNamara et al. (ibid) stated that information added to an original biology instructional text for coherence enhancement was advantageous to low-knowledge readers only. However, an original minimally coherent format text was useful for high-knowledge readers more than an enhanced one.

Unlike the study done by McNamara et al. (ibid), this experiment was conducted within the framework of CLT in which cognitive load approaches were used to measure effort and the efficiency. Accordingly, the current experiment used expanded and reduced versions instead of high-cohesive and low cohesive texts used by McNamara et al. (ibid) in their study. In the expanded and reduced versions, the sentences were added or removed while in the high-cohesive texts and low cohesive texts, the content of the versions were modified by changing cohesive devices.

Though CLT has been introduced since 2007 (Huynh, 2007), no studies on cognitive load effects as expertise reversal effect have been carried out in the Vietnamese context. The paper is the first study in Vietnam to investigate the expertise reversal effect on EFL area related to reading comprehension. Based on a review of the study by McNamara et al (ibid), the experiment had the following aims:

Firstly, the experiment was investigated within the CLT and assumed that cognitive processes caused expertise reversal effect while McNamara et al's (ibid) study did not measure any cognitive load and was just based on learning outcomes and studying times. McNamara et al. (ibid) firstly used different cohesive versions of a biology text and a history text (McNamara and Kintsch, 1996). The experiment assumed that high knowledge readers (or experts) do not benefit from expanded versions because they are overloaded by extraneous processing due to redundant information.

Secondly, the experiment used the subjective ratings in the expertise reversal effect. The experiment assumed that how high level readers (experts) and low level readers (novices) perceived difficulty of comprehension of different versions (expanded and reduced versions).

2. Method

Participants

The participants were 120 Vietnamese second-year students consisting of 60 second-year students studying in the department of Geography and 60 second-year students studying in the department of Mathematics, Ho Chi Minh City University of Education. Their English proficiency was quite different because the students took different English for Specific Purposes (ESP) courses for Geography and for Mathematics, respectively. The participants were divided into an expert group and a novice group. The expert group

consisted of the 60 students from the Department of Geography because the material used in this experiment was a geographical text that required them to have appropriate English proficiency in Geography. The novice group included the 60 students from the Department of Mathematics. They were categorized as novices because they were not familiar with the materials used in the experiment. Both experts and novices were randomly assigned to either a reduced or an expanded text version group.

Materials

The Geographical text entitled "*What killed the dinosaurs?*" was extracted from the book "*Earth Science*" (Feather R.M., Snyder S.L., 1993). The original text had 124 words. A reduced version included text in which some sentences were removed from the original text. The reduced version had 60 words.

The expanded version consisted of extra seven sentences added to the reduced version to explain more about dinosaur extinction. For example, sentences such as "In the search for answers to what killed the dinosaurs, scientists have looked beyond fossils. There is increasing evidence that the impacts of meteorites have had important effects on earth, particularly in the field of biological evolution" were added to the first paragraph to explain evidence of dinosaur extinction. The length of the expanded version was 237 words.

Procedure

Half of the experts and novices were randomly allocated to either of the two reduced or expanded text versions. During the learning phase, participants were required to read either of the two versions and answer 6 questions in 12 minutes (2 minutes each). After the learning phase, participants were given the test questions. They were required to answer the test questions without seeing the text. 2 out of 5 questions were identical to 2 questions presented during the learning phase for the two versions. The 2 identical questions were "*When did the last species of dinosaurs become extinct?"* and "*How long had dinosaurs dominated the land?"* These 2 questions were chosen because they serve as background for understanding both versions of the text.

After the learning phase, participants ranked the subjective difficulty score of the textual materials from 1 as *"extremely easy"* to 9 as *"extremely difficult"*. The duration of the test phase was 10 minutes (2 minutes for each question). The appendix presents the questions used in both learning and test phases.

Scoring

In both phases, one mark was given for a correct answer and a zero mark for an incorrect answer. An answer was deemed incorrect if it had a wrong choice or lacked key words of the correct answer. The answers to the questions were explicitly stated in the text and only one sentence was required as an answer for each of them. For example, the correct answer to question 1 of the learning phase "*What is one theory of dinosaur extinction?*" was "*A hypothesis of dinosaur extinction is that a large meteorite collided with earth*". The key words for the answer were "*a large meteorite*". Similarly, the correct answer to question 5 in the test phase "*How long had species of dinosaurs dominated the land?*" was obtained from the sentence "*Species of dinosaurs had dominated the land for 130 million years*" with the key words being "*for 130 million years*".

The maximum total score for the tests was 6 marks in the learning phase and 5 marks in the test phase. The total score of each participant in the two phases was then converted to a percentage for analysis.

3. Results

The performance scores in the learning phase and the test phase were analyzed by a 2

(instructional text versions: reduced and expanded version) x 2 (expert and novice groups) ANOVA (see Table 1). The 0.05 significance level was used throughout the analysis. The performance mean scores in Table 1 are expressed graphically in Figure 1 and 2 for each expertise group indicating the mean scores of participants.

In the learning phase, the main effect of version indicated that there was no significant difference, F (1,116) = 2.50, MSE = 889.0, p = .116. The main effect of expertise group indicated a significant difference, F (1,116) = 5.28, MSE= 889.0, p = .023, *partial Eta Squared* = .044. The experts (geography students) obtained higher scores than the novices (mathematics students). There was a significant interaction between expertise groups and versions, F (1,116) = 12.41, MSE = 889.0, p = .001, *partial Eta squared* = .097. Following the significant interaction, simple effects tests indicated that, for the expert group, in the learning phase the reduced version had significantly higher mean scores than those of the expanded version, F (1,116) = 13.04, MSE = 889.0, p < .001, *partial Eta Squared* = .101. For the novice group in the learning phase, the expanded version did not differ significantly from the reduced version F (1,116) = 1.88, MSE = 889.03 p = .215. Figure 1 describes the distribution of the learning scores of novices and experts in two versions: reduced and expanded. The figure shows the lowest score and the highest score.

In the test phase (see Table 1), the main effect of expertise groups showed a significant difference, F (1,116) = 5.93, MSE = 297.3, p = .016, *partial Eta Squared* = .044 and the main effect of versions was significantly different, F (1,116) = 7.00, MSE = 297.3, p = .009, *partial Eta Squared* = .057. There was also a significant interaction between the two groups and versions, F (1,116) = 84.8, MSE = 297.3, p < .001, *partial Eta squared* = .422. Simple effect tests showed that, for the expert group, the reduced version had significantly higher mean scores than those of the expanded version, F (1,116) = 70.3, MSE = 297.3, p < .001, *partial Eta Squared* = .377, while for the novice group, the expanded version was better than the reduced version, F (1,116) = 21.5, MSE = 297.3, p < .001, *partial Eta Squared* = .157 (see Figure 2). Figure 2 revealed that higher knowledge students learned better from the reduced version than from the expanded version, while the lower level students learned better from the expanded version than from the reduced version.

Table 1

Percentage means and Standard deviations of performance scores in the Experiment

Phase	Group	Version	Mean	Std. Deviation	N
Learning	Novice	Expanded	54.96	34.52	30
		Reduced	44.40	28.48	30
		Total	49.68	31.82	60
	Expert	Expanded	48.29	31.36	30
		Reduced	76.09	23.85	30
		Total	62.19	30.97	60
	Total	Expanded	51.62	31.87	60
		Reduced	60.25	30.55	60
		Total	55.93	31.89	120

Phase	Group	Version	Mean	Std. Deviation	N
Test	Novice	expanded	26.0	24.15	30
		Reduced	5.33	10.41	30
		Total	15.6	21.18	60
	Expert	expanded	14.66	8.60	30
		Reduced	42.0	20.5	30
		Total	23.3	24.6	60
	Total	expanded	15.33	20.94	60
		Reduced	23.66	24.56	60
		Total	19.50	23.11	120

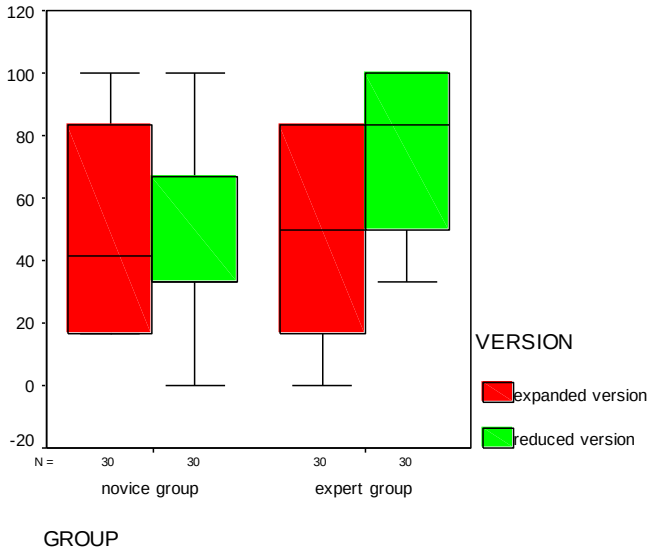

Figure 1. Performance scores in the learning phase

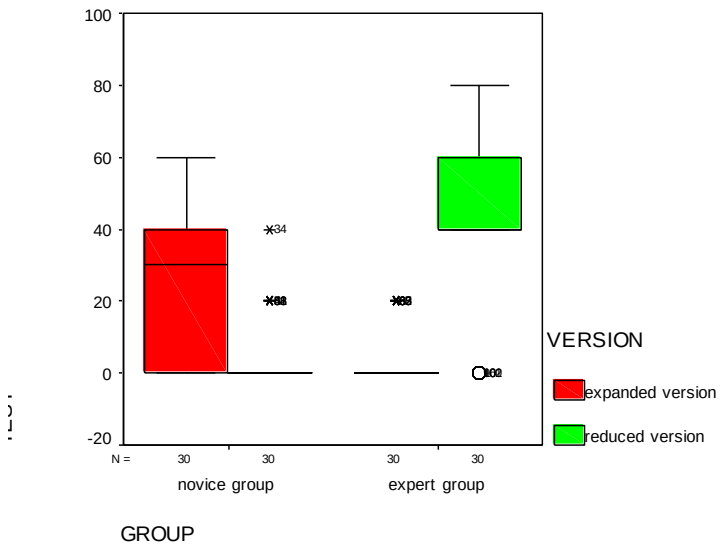

Figure 2. Performance scores in the test phase

Mental effort ratings (Table 2) demonstrated that the main effect of version was not significant, F (1,116) = .011, *MSE* = .747, *p* = .916. The main effect of expertise group was significant, *F* (1,116) = 22.5, *MSE* = .747, *p* < .001, *partial Eta Squared* = .163 (see Table 2). There was a significant interaction between the groups and versions, *F* (1,116) = 18.7, *MSE* = .747, p < .001, *partial Eta Squared* = .139. Simple effect tests revealed that the effort scores of the expanded version were higher than those of the reduced version for the expert group, *F* (1,116) = 9.83, *MSE* = .747, *p* = .002, *partial Eta Squared* = .078 while the effort scores of the reduced version were higher than those of the expanded version for the novice group, *F* (1,116) = 8.92, *MSE* =.747, *p* = .003, *partial Eta Squared* = .071 (Figure 3).

According to Paas and Van Merrienboer (1993), an efficiency score can be generated by using the difference between the z score of performance and the z score of effort. The main effect of version was not significant, *F* (1,116) = 1.34, *MSE* = .921, *p* = .209. The main effect of expert groups was significant, *F* (1,116) = 21.4, *MSE*=.921 p < .001, *partial Eta Squared* = .156 (See Table 4). There was a significant interaction between the groups and versions, *F* (1,116) = 27.0. *MSE* = .921, *p* < .001, *partial Eta Squared* = .189. Simple effect tests indicated that the reduced version was relatively more efficient than expanded version for the expert group, *F* (1,116) = 20.2, *MSE* = .926, p < .001, *partial Eta Squared* =.148. In contrast, the expanded version was relatively more efficient than the reduced version for the novice group, *F* (1,116) =8.17, *MSE* = .926, p = .005, *partial Eta Squared* =.066 (Figure 4).

Table 2

Effort and relative instructional efficiency in the experiment

Group	Version	Effort		Efficiency	
		Mean	SD	Mean	SD
Expert	Expanded	5.53	0.937	.0520	1.18703
	Reduced	4.83	0.648	.8025	.83503
	Total	5.18	0.837	.4273	1.08561
Novice	Expanded	5.60	1.102	-.3472	.82794
	Reduced	6.27	0.691	-.5074	.95412
	Total	5.93	0.972	-.4273	.88933
Total	Expanded	5.57	1.015	-. 1476	1.03442
	Reduced	5.55	.982	.1476	1.17745
	Total	5.56	.994	.0000	1.07729

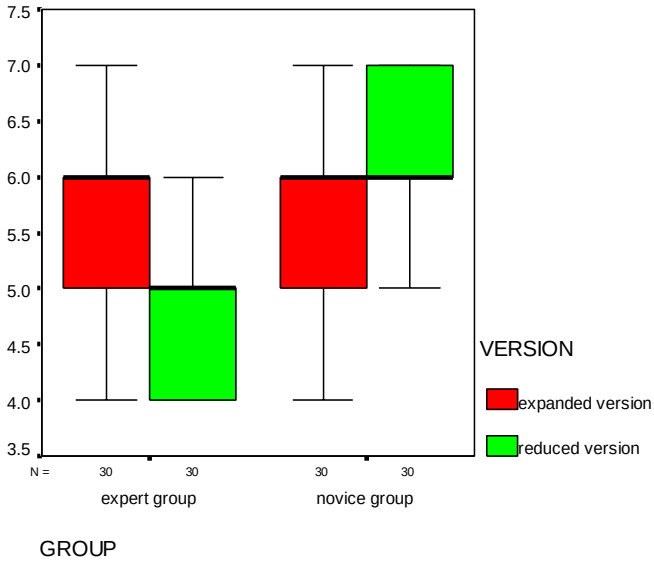

Figure 3. Effort scores of the two groups

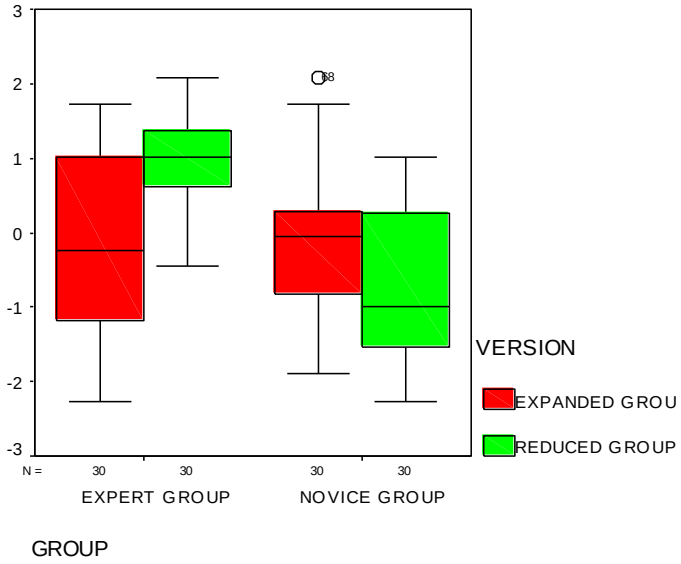

Figure 4. Efficiency scores of the two groups

4. Discussion

As expected, the results showed that in the learning phase there was a significant interaction between the two groups and the two versions. The results demonstrated that, for the expert group, the reduced version outperformed the expanded version. The experts had better English proficiency in Geography. Thus, the experts were able to answer the question quickly and accurately. To comprehend the reduced version, the experts found it easy to find key words and to answer the questions. However, for the expanded version, the experts found it more difficult to answer the questions because the information provided and added to the version were redundant and caused an extraneous cognitive load. The results of the experiment in the learning phase for experts were different from previous studies (Oblinger and Oblinger, 2005; Chujo and Utliyama, 2005) in which text length had no significant effect on

reading comprehension.

Contrary to expectation, in the learning phase, the results revealed that the expanded version did not significantly outperform the reduced version for the novices. The results in the learning phase for novices were consistent with some previous studies (Jalilehvand, 2012; Strother and Ulijn, 1987; Mehrpour and Riazi, 2004) which showed a non-significant effect of text length on reading comprehension.

The results do not accord with McNamara et al's (1996) data. Even though the expanded version had extra seven sentences explaining more about dinosaurs' extinction, this addition seemed not enough to fill the gap between novice and experts' background knowledge and the content of the text. One reason might be that English is the mother tongue of high school students in McNamara et al's (1996) study while English is a foreign language for the Vietnamese students (ESP) in this experiment. Accordingly, the students of this experiment need to acquire adequate English proficiency as a second language to have appropriate background knowledge for understanding the content of the text. A second reason is that novices in the experiment were students from the Department of Mathematics who knew very little about geographical English, the domain of the text. For these two reasons, adding more information in the expanded version may not help the novices to achieve active processing in reading comprehension. In other words, the length of versions did not help novices to infer the content of the text in the learning phase. Nevertheless, the experiment results showed that both reduced and expanded versions did not make a difference for the novices in the learning phase.

Unlike the "more effort" hypothesis suggested by McNamara et al. (ibid), the performance scores and effort scores of the experiment findings showed that the reduced version was beneficial to the experts as they need less effort to comprehend it. The reduced version in the experiment was a "challenging text" as McNamara et al. (ibid) suggested. The results of the mental effort scores also showed that McNamara's hypothesis of putting in more effort was not supported. How much the experts understand the reduced version depend on how much they understand geography as the subject matter and whether knowledge they learnt from Department of Geography enough for them to comprehend the text. Obviously, the experts needed extra processing and differencing to understand the version.

Next, the expanded version could help the novices to recall its content and answer the question because they already read this version in the learning phase and may have sufficient schemas to answer the questions in the test phase without looking at the text. In contrast, the novices who read the reduced version in the learning phase did not have sufficient schemas to recall the content and answer the questions precisely. For the experts, the background schemas helped them to recall more effectively. However, the experts who previously read the expanded version might have trouble recalling the content and answering the questions in the test phase due to extraneous and redundant cognitive load caused by the expanded version they learnt.

The results of recalling in the test phase of this experiment were in line with that of MacNamara et al.'s (ibid) studies. Accordingly, the expanded version that helped the novices recall its content turned out to be counter-productive to the experts because it provided more appropriate schemas for novices to answer the questions while created a redundant and extraneous cognitive load for the experts. On the contrary, if novices did not get suitable schemas, it would generate an extraneous cognitive load for them to read the

reduced version.

Mental efforts scores showed significant interactions. It took more efforts for experts than for novices to understand the expanded version. These findings contradict with those of McNamara et al's study. Also, instructional efficiency scores indicated that reduced version may be more efficient than expanded version for experts whereas the latter seemed more efficient than the former for novices.

5. Implications

Regarding educational implications, the results of this paper suggest that the alternative versions of a text should be designed appropriately to readers' knowledge. The use of suitable versions may be very effective in facilitating reading comprehension, especially in an EFL context. Instructors should not design a reading comprehension version that might impose an extraneous cognitive load for readers and do not enhance their reading comprehension skills.

The current research has provided some further insights into the relevant constructs. Of the two reduced and expanded versions of a text, the reduced version had a significant positive influence on high level readers while the expanded version helped enhance reading comprehension for lower level readers.

In fact, instructors often provide all students with one general version of a text without considering the difference in their levels of knowledge. The findings implied that teachers should give students adequate versions of a text to improve learners' reading comprehension.

Furthermore, the main results of the paper revealed that the expanded version of a text could benefit novices significantly and thus, should be designed in a way to improve their reading comprehension. In contrast, the reduced version of a text needs to be designed to enhance the reading process of experts.

6. Conclusion

The present study found that reading instructions in ESP (English for Geography and History) used by readers of different levels could yield expertise reversal effect. The significant interaction between the two groups and two versions of the experiment indicated a negative correlation between the versions and the students' expertise. The results showed that it was not the expanded version but the reduced version did enhance reading comprehension for experts because they were equipped with more sophisticated schemas for reading comprehension■

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