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COGNITIVE LOAD THEORY AND THE ENGLISH LANGUAGE INSTRUCTION

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ABSTRACT

Working memory is used to process information of our mental representations and new knowledge. In learning English language, students are faced with various kinds of material and instruction that relate to the development of their knowledge and skills. However, extraneous information may overload their cognitive load and inhibit their knowledge and performances. Therefore, the theory of cognitive load effects provides a solution towards the overloading of cognitive capacity by introducing cognitive load effects. Cognitive load theory itself deals with the instructional design methods that use the limited cognitive capacity of learners. There are three sources or types of cognitive load: the intrinsic load, extraneous load, and germane load. By analyzing an English textbook for class VIII secondary level in Indonesia designed by the Ministry of Education and Culture for distance learning in the Covid-19 pandemic era, this paper points out several cognitive load principles that create a better schema construction and automation that contribute to the decreased cognitive load.

KEYWORDS: *Cognitive Load Theory, Instructional Design, Cognitive Load Effects*.

INTRODUCTION

Cognitive load theory concerns with the idea that instructional materials will be effective if it does not overload the working memory of learners. Cognitive load theory is the theory that aims on the presentation of information for learners' task that may enhance intellectual performance (Sweller, Van Merrienboer, & Paas, 1998). In learning a language, learners are faced with various tasks that may even overload their cognitive capacity. In learning a second language, learners are faced with multiple tasks on language skills: listening, speaking, reading and writing, and language sub-skills such as grammar, pronunciation, and vocabulary. Besides that, the content of language learning involves various concepts that may cause overload cognitive demand (Lin & Chen, 2006). Therefore, it is crucial to construct an instructional material that limits extraneous cognitive load and enhance learner's performance. This paper presents

some cognitive load principles that may be used to construct an effective English language learning instruction. The cognitive human architecture will be discussed along with the principles of cognitive theory and the instructional design in English language learning.

Therefore, this study examined the textbook used in the teaching of English for Secondary class VIII students to answer the question: *What are the cognitive load effect examples found in the textbook?*

Literature Review

Cognitive Architecture and Language Learning

Sweller et al. (1998) point out some aspects of human cognitive architecture which are working memory, long-term memory, schema construction, and schema automation.

Working memory is a consciousness process that can be controlled by human, in which all other cognitive functioning is processed (Sweller et al., 1998). Furthermore, working memory is used to process information of our mental representations and new knowledge. However, the capacity and duration of human's working memory is limited since it can only hold seven items or elements in a time (Miller, 1956). Therefore, it is important not to overload the working memory in learning since it may affect the effectiveness of learning process.

As working memory process information, long-term memory plays an important role in storing the information permanently. The information in the working memory can be processed since one acquires a knowledge structure in the long-term memory. In addition, long-term memory influences the way learners process information such as solving problems, organizing, and learning in the working memory. Long term-memory, furthermore, stores knowledge in forms of schema. "Schemas provide elements of knowledge" (Sweller et al., 1998, p. 255) which are stored in the long-term memory. The schemas then, will have an automation where the construction of schemas take place and processed through working memory after sufficient practice.

In learning English language, students are faced with various kinds of material and instruction that relate to the development of their knowledge and skills. However, extraneous information may overload their cognitive load and inhibit their knowledge and performances. Language proficiency level and familiarity on the subject matter of students also matters in the construction of the effective instruction (Lin & Chen, 2006). In learning English language, learners often are required to perform specific tasks that

impose on their cognitive system. Therefore, learners tend to find it difficult and overwhelming to understand the English content lessons.

Cognitive Load Theory

Cognitive load theory focuses on how the capacity of information in our working memory helps decide the effective instruction (Renkl, Atkinson, & Grobe, 2004). In other words, cognitive load theory deals with the instructional design methods that use the limited cognitive capacity of learners. Cognitive load theory, then, can be used to promote learning in forms of schemas (Kirschner, 2002). There are three sources or types of cognitive load.

Intrinsic Cognitive Load

Intrinsic load is the "cognitive load imposed by the inherent difficulty of instructional design" (Tasir & Pin, 2012 p. 451). The intrinsic load does not relate to the structure of instruction but emphasizes on the complexity of information that must be processed simultaneously in the working memory and its element interactivity (Sweller et al., 1998). The intrinsic cognitive load is also known as productive cognitive load. This cognitive load is determined by the degree of interactivity in acquiring learning objectives. Furthermore it is related to the connections between tasks in working memory and integrating them in knowledge based (Kalyuga, 2007). Kalyuga adds that intrinsic load can be managed by simplifying task such as omitting some interacting elements and by appropriately segmenting and sequencing tasks from simple to complex. Simplifying task is necessary in learning a second language.

Extraneous Cognitive Load

Extraneous cognitive load is "associated with a diversion of cognitive resources on activities irrelevant to learning goals because of design related factors, such as poor presentation design, inappropriate selection and sequencing of learning tasks, or inadequate instructional support" (Kalyuga, 2007, p. 514). This explains that the extraneous cognitive load which is also known as wasteful cognitive load has unnecessary elements of information in the working memory. This kind of load may have a large impact on novice learners of English language since with limited proficiency in the language, and being imposed to too many information will consequently overload the cognitive capacity. This kind of cognitive load does not contribute directly to learning. However, it can effective for expert learners (Renkl et al., 2004).

Germane Cognitive Load

Germane cognitive load contributes directly to the process of schema construction and automation that results from the instructional activities directed towards the instructional goal (Sweller et al., 1998). This indicates that the Germane cognitive load is caused by a task that is constructed to enhanced learning. Thus, this cognitive load may work within working memory limit. Germane cognitive load can be in form of self-explanation and worked examples (Renkl et al., 2004). Worked example is often used and found to be effective in teaching English language for novice learners especially in the teaching of grammar.

Cognitive Load and Instructional Design in English Language Teaching

The role of memory in language learning has become important for researchers in the area of second language acquisition. The capacity of one's memory can affect the acquisition of language since various tasks demand learners to work on and store new knowledge to enhance their language skills. This shows that instruction is crucial in providing the best source of information for learners. Effective learning can be achieved by reducing extraneous cognitive load and enhance working memory to be able to be devoted to the germane load (Sweller, 2007). Cognitive load theory has been used to design instructional procedures with the objective to reduce extraneous cognitive load and enhance germane cognitive load (Chen & Chang, 2009).

VanPatten (2007) points out some claims that relate second language acquisition to the working memory. He states that since learning language engages with comprehension, comprehension is demanding for cognitive processing and working memory. Furthermore, learners have a limited capacity of processors that causes them not having the ability to acquire the same knowledge as native speakers in their language processing (VanPatten, 2007). Furthermore, VanPatten states that learners will process non-redundant linguistic markers before redundant ones. Therefore, in order to acquire a language, learners should not be exposed to materials that are redundant.

In Indonesia, English language has been learned at early stage of a learner's education. It has been taught since grade 4 of elementary level. Most teaching and learning processes of English language use various kinds of textbooks based on level of education. The activities and tasks in the English language textbooks commonly use the task-based approach. The textbooks are designed with various task and activities that focus on the English skills: listening, speaking, reading, and writing with emphasis on grammar, vocabulary, and pronunciation. The activities are quite interactive; however, most of the instructions can cause an extraneous cognitive load where

unnecessary information are added and consequently does not facilitate learners' language learning.

Since cognitive load theory has been used to reduce extraneous cognitive load, there are several cognitive load principles that create a better schema construction and automation that contribute to the decreased cognitive load. The effects are discussed in the discussion section based on the material of the study.

Research Methods

This study employed a qualitative research design, specifically a document analysis. The study analyzed qualitatively the English language teaching materials for junior high school students taken from "*Modul Pembelajaran Jarak Jauh pada Masa Pandemi COVID-19 untuk Jenjang SMP, Mata Pelajaran Bahasa Inggris*" (Distance Learning Module in the COVID-19 Pandemic Era for Junior High School Level: English Subject) (Gunawan & Satiti, 2020).

Results and Discussions

Cognitive Load Effects

Effect 1: Goal-free effect

The goal-free effect has been proven to be effective in building schema construction and reducing learners' extraneous cognitive load caused by means ends analysis (Sweller et al., 1998). "Goal free problems do not permit problem solvers to extract differences between a current problem state and the goal state because no goal state is specified, short-circuiting the entire means-ends process. In order to solve goal-free problems, problem solvers must find an alternative strategy to means-ends analysis" (Sweller et al., 1998, p. 271).

Goal-free problems may reduce learners' extraneous cognitive load since it gives learners the focus only on the problems that create schema acquisition and automation and most importantly facilitate learning. It is said that this effect is effective only for problems that have a limited search space. The following figure 1 shows the example of this.

Figure 1 is an example of this goal-free effect since there is no definite goal of the instruction. In this instruction, learners may use the given text to learn other various English language skills. For example, besides listening and simple tenses, learners may also use the text to enhance their vocabulary and pronunciation. They can read the text and try to pronounce the words correctly or even retell the story for their peers. In

doing so, they can concentrate on only one aspect of the problem that may be beneficial for their schema acquisition and automation.

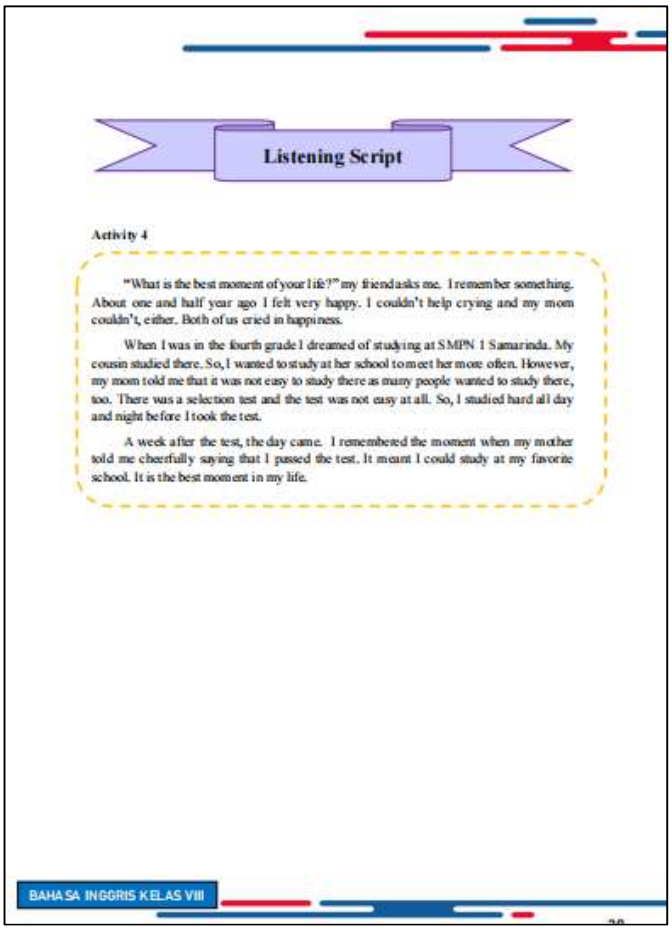

Figure 1. Goal-free effect example

Effect 2: Worked-example effect

Worked-example focuses on the attention on problem states and solution steps that assist learners to come up to solutions or schemas (Sweller et al., 1998). The worked-example may be used in a way that provides step-by-step solution that may reduce extraneous cognitive load caused by weak-method of problem solving. The worked-example focus on learners' attention on problems stated and useful solution steps (Van Merrienboer & Sweller, 2005). Using this type of model, learners learn several examples before they involve in problem solving tasks (Schwonke, Renki, Salden, & Aleven, 2011). The following figure 2 is an example.

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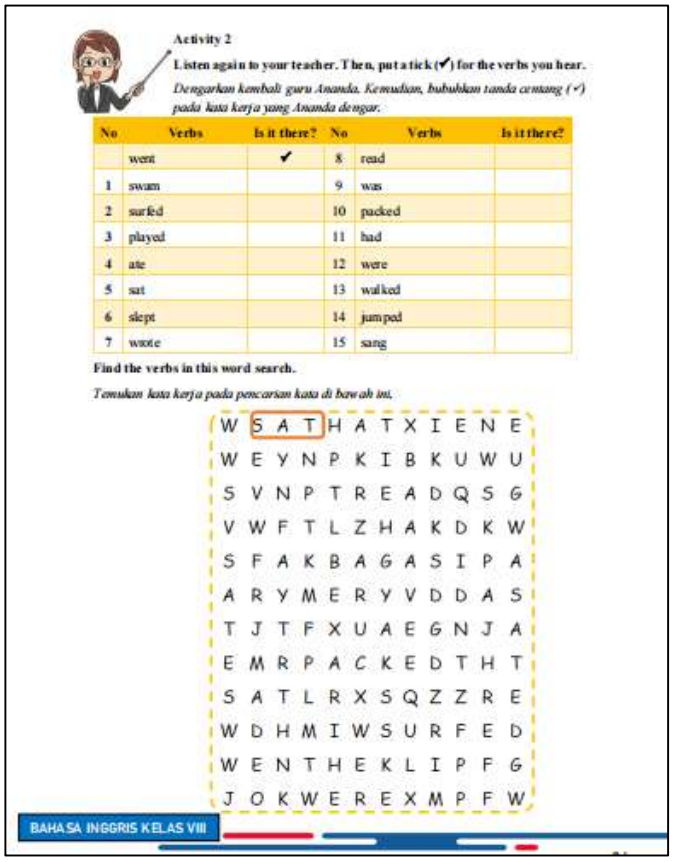

No	Verbs	Is it there?	No	Verbs	Is it there?
	went	✔	8	read	
1	swam		9	was	
2	surfed		10	packed	
3	played		11	had	
4	ate		12	were	
5	sat		13	walked	
6	slept		14	jumped	
7	wrote		15	sang	

W	S	A	T	H	A	T	X	I	E	N	E
W	E	Y	N	P	K	I	B	K	U	W	U
S	V	N	P	T	R	E	A	D	Q	S	G
V	W	F	T	L	Z	H	A	K	D	K	W
S	F	A	K	B	A	G	A	S	I	P	A
A	R	Y	M	E	R	Y	V	D	D	A	S
T	J	T	F	X	U	A	E	G	N	J	A
E	M	R	P	A	C	K	E	D	T	H	T
S	A	T	L	R	X	S	Q	Z	Z	R	E
W	D	H	M	I	W	S	U	R	F	E	D
W	E	N	T	H	E	K	L	I	P	F	G
J	O	K	W	E	R	E	X	M	P	F	W

Figure 2. Worked-example effect

Figure 2 shows a grammar material that has a worked-example instruction and material. However, teachers need to be careful since this may cause an extraneous cognitive load due to the amount of information for the learners. In the first instruction in *Activity 2*, learners are provided with an instruction to listen to their teacher and put a tick on the table for the verbs they hear. While in the second instruction the students are asked to find the verbs in the word search. Since it is for young learners, this kind of instruction may cause an extraneous cognitive load, where they might not listen to their teacher and split their attention to the verbs in the word search. The worked-example can only be found when the instruction is designed in a way that does not cause split attention and redundancy (Van Gog, Kester, & Paas, 2011). However, the instructions help in reducing overload information for the learners because they are simplified and relevant.

Effect 3: Completion problem effect

The completion problem effect occurs since many thinks that the worked-example does not strongly facilitate learning as students are only instructed to follow or learn the given examples without being able to be more independent in their learning. However, as worked-example, this effect also reduces the extraneous cognitive load. Sweller et al. (1998) point that although this effect is good, it may cause the instructional designers to end up with too many numbers of decisions that may affect the effectiveness of the instruction since learners may know about the part of the solution before solving the other part and have to perform a nontrivial completion.

Figure 3. Completion problem effect example

Figure 3 can be used as an example of a completion problem effect. On the material/text, there is a clear instruction on how to do *Activity 11* without having to see too many instructions and examples. Students may be well-instructed without splitting their attention to other instruction or activity.

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Effect 4: Split-attention effect

Split-attention is a phenomenon that often occurs in instructions of multimedia learning. However, an instruction that contains multiple sources of information such as between pictures and texts may also cause split-attention effects for the learners. Learners often have to split their attention for instructions that present pictures and texts. Furthermore, learners will repeatedly search for information in both elements and mapping of texts and pictures to comprehend the content of the instruction (Florax & Ploetzner, 2010). Generally, split-attention occurs when learners have to work on multiple information before it is being understood (Sweller et al., 1998).

As shown in Figure 2, a split attention effect may cause students to lose their focus. However, a solo instruction and one main activity may reduce this issue. The following is a good example taken from the textbook.

Figure 4. Split attention effect example

Compared to figure 2, there is only one main instruction in the activity in Figure 4. Students can only focus on working the word search instead of at the same time listening to their teacher. To some extent this reduces extraneous cognitive load.

Effect 5: Redundancy effect

The redundancy effect happens when source of information can be used without connecting it to other information and self-contained (Sweller et al., 1998). As explained, redundancy effects occur when unnecessary information is added to learners' working memory that leads to an extraneous cognitive load.

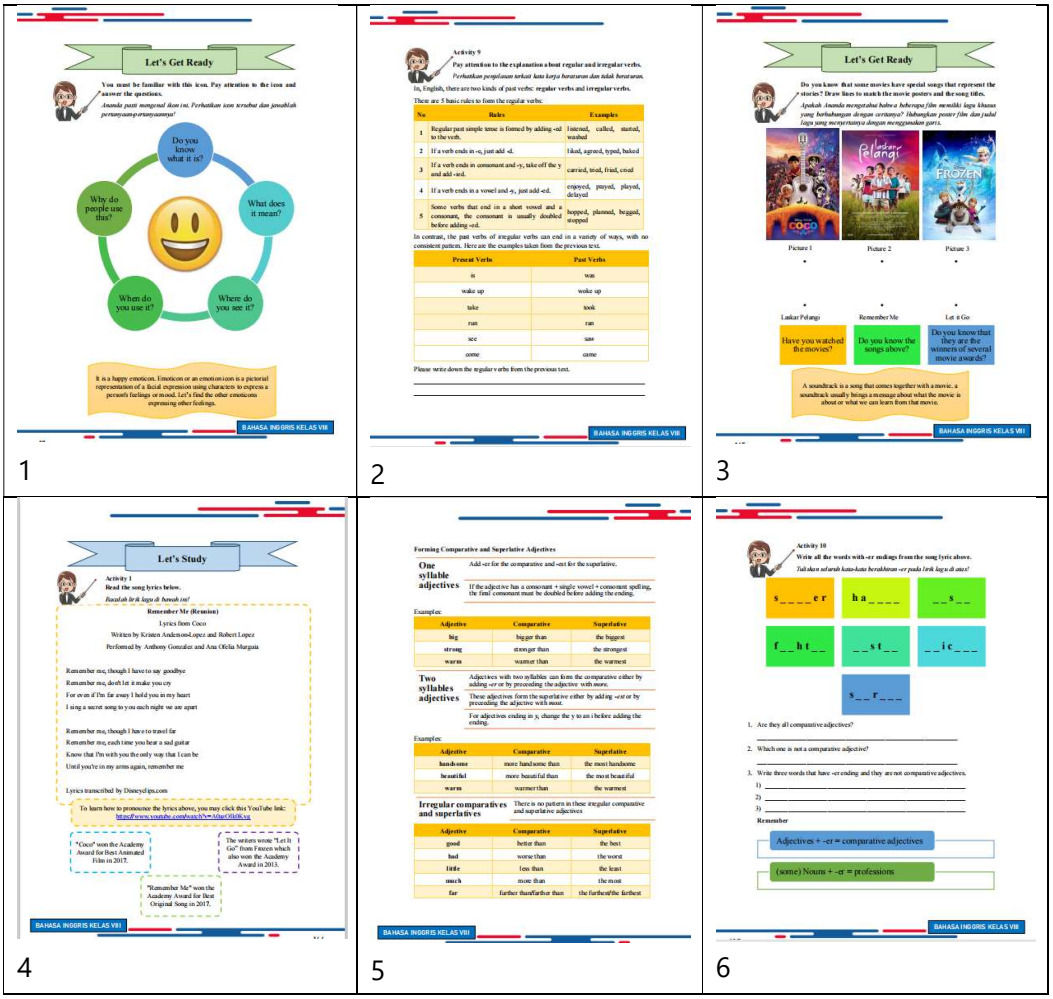

Figure 5. Redundancy effect example

Figure 5 shows six examples of redundancies taken from the textbook, in which there are too much information provided for the learners. For novice learners, this typical instruction may be applicable; however, the format of the instruction may be reduced by omitting, some information.

As an example, picture 4 in Figure 5 shows a redundancy effect since in just one instruction there are two materials where the students are required to read to the transcript of a song and are able to watch by clicking the YouTube link at the same time. What the teachers can do in order to reduce the extraneous cognitive load is by providing only the YouTube link and ask the students two watch and listen to the song or provide only the song transcript.

In addition, these kinds of instructions, although with relevant detail effects, can cause an extraneous cognitive load. The information provides the students with list of pictures, list of language feature explanations, and more than one material within a single instruction. This definitely overloads the cognitive capacity where learners may be confused on how to work on the task. However, there are always ways to reduce it by applying the cognitive load effects mentioned earlier. In this way, students will only see the relevant information and indeed reduce their working memory capacity.

CONCLUSIONS

The activities in the English textbook for class VIII secondary level designed by the Ministry of Education and Culture for distance learning in the COVID-19 pandemic era is quite interactive, however, most of the instructions can cause an extraneous cognitive load where unnecessary information are added and consequently does not facilitate learner's language learning. Referring to that, this paper has pointed out several cognitive load effects and improvements in English language teaching materials. Since cognitive load theory has been used to reduce extraneous cognitive load, there are several cognitive load principles that creates a better schema construction and automation that contributes to the decreased cognitive load. The effects are goal-free effect, worked-example effect, completion problem effect, split-attention effect, and redundancy effect. The improvement of instructions may be effective in order to reduce learner's extraneous cognitive load and assist in enhancing learner's performance and ability in English language learning especially in the Indonesian learning context.

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