A Study on EFL Instructional Design from the Perspective of Cognitive Load Theory

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Abstract: Cognitive load is commonly defined as the amount of mental effort that performing a specific task imposes on a learner's cognitive system. For EFL learners, with their limited English proficiency and cultural immersion, always find it overwhelming to comprehend a content lesson delivered in English. Cognitive load theory draws on an understanding of human cognitive architecture to provide explanations for why certain designs of multimedia educational materials are effective and why some are not. This study evaluated the split-attention and redundancy principles in an Intensive Reading lesson for non-English majored students and their potential to decrease mental effort and increase learning.

Keywords: Cognitive Load theory; Instructional design; Cognitive load effects

1. Introduction

Cognitive load theory aims to explain how the information processing load induced by learning tasks can affect students' ability to process new information and to construct knowledge in long-term memory. Its basic premise is that human cognitive processing is heavily constrained by our limited working memory which can only process a limited number of information elements at a time. Cognitive load is increased when unnecessary demands are imposed on the cognitive system. (Sweller, 1988) . In order to promote learning and transfer, cognitive load is best managed in such a way that cognitive processing irrelevant to learning is minimised and cognitive processing germane to learning is optimised, always within the limits of available cognitive capacity (van Merriënboer et al. 2006).

Most research on Cognitive Load Theory has uncovered many instructional design considerations for learning complex tasks. EFL is a complicated subject to teach because it involves interpretational, mathematical, and logical components. Research focusing on the complexities faced by instructional designers have called for pedagogical strategies to equip instructional designers with the ability to problem solve and make decisions. As for the case of Chinese, the study of CLT has not received much attention, students' psychological mechanism is not recognized in EFL teaching and research.

2. Cognitive load Theory and Instructional Design

Cognitive load theory is mainly concerned with the learning of complex cognitive tasks, where learners are often overwhelmed by the number of information elements and their interactions that need to be processed simultaneously before meaningful learning can commence. According to cognitive load theory, instructions can impose three types of cognitive load on the learner: intrinsic load, extraneous load, and germane load. Proper measurement of the different types of cognitive load can help us understand why the effectiveness and efficiency of learning environments may differ as a function of instructional formats and learner characteristics. Task complexity and the learner's prior knowledge determine the intrinsic load (IL), instructional features that are not beneficial for learning contribute to extraneous load (EL), and instructional features that are beneficial for learning contribute to germane load (GL). IL should be optimized in instructional design by selecting learning tasks that match learners' prior knowledge, whereas EL should be minimized to reduce ineffective load and to allow learners to engage in activities imposing GL.

Instructional design is a perpetual concern of educational psychology and it is a bridge to transform teaching theory into teaching practice. Instructional Design focuses on the design process of instruction based on learning theories and their implementation using modern tools, such as computers or mobile devices. Cognitive load theory provides evidence-informed principles that can be applied to the design of instructional messages or relatively short instructional units, such as lessons, written materials consisting of text and pictures, and educational multimedia (instructional animations,videos, simulations, games). It shares several of its principles with mental workload models,which focus on workplace performance rather than learning and instructional design , and with the cognitive theory of multimedia learning, which has an exclusive focus on the design of multimedia materials (CTML; Mayer 2014)

3. Research on Cognitive Load measurement

There has been an ongoing research effort to examine issues related to the measurement of cognitive load. The most commonly used method is the subjective measurement technique that was originally introduced by Paas (1992) to provide an overall measure of cognitive load. Although this measure has been extensively and successfully used showing good psychometric properties, some researchers remain skeptical about its capacity to measure cognitive load, even when comparisons with physiological measurement techniques have shown that the subjective rating scale is just as valid and reliable and easier to use a subjective techniques. The main advantages of the subjective technique over physiological techniques are its sensitivity and its simplicity. In contrast to physiological measurement techniques, the subjective rating scale is sensitive to small differences in invested mental effort and task difficulty. Whereas the simplicity of the subjective rating scale is considered its major strength, because it can be easily used in research and practice, it is also considered by many as its major weakness. Due to its simplicity, it provides an overall measure of cognitive load (i.e. intrinsic plus extraneous load) and therefore cannot easily be used to differentiate between the different types of cognitive load.

4. Cognitive load effects

Sweller and other researchers have discussed human cognitive architecture including an outline of cognitive load theory and its general principles. The following are 3 typical effects that are of importance in the study.

4.1 Split-Attention Effect

The split-attention effect stems from research on worked examples and was first reported by Tarmizi and Sweller. For instance, a worked example in the domain of geometry might consist of a diagram and its associated solution statements. The diagram alone reveals nothing about the solution to the problem and the statements, in turn, are unintelligible for the learners until they have been integrated with the diagram. Learners must mentally integrate the two sources of information in order to understand the solution, a process that yields a high cognitive load and hampers learning. This split-attention effect can be prevented by physically integrating the diagram and the solution statements, making mental integration superfluous and reinstating the positive effects of worked examples. The split attention effect not only relates to the spatial organization of information sources but also to their temporal organization. Mayer and Anderson (1992) found that animation and associated narration need to be temporally coordinated in order to decrease cognitive load and facilitate learning.

4.2 Redundancy Effect

While the split-attention effect grew out of the worked example effect, redundancy effect, in turn, grew out of the split-attention effect. Split attention occurs when learners are confronted with two complementary sources of information, which cannot stand on their own but must be integrated before they can be understood. But what happens when the two sources of information are self-contained and can be understood without reference to each other? Chandler and Sweller (1991) used a diagram demonstrating the flow of blood in the heart, lungs and rest of the body together with statements that described this flow of blood in text. Thus, the diagram and the statements contained the same information and were fully redundant. It was found that only presenting the diagram was superior to presenting both sources of information together. This redundancy effect is due to the fact that effortful processing is required from the learners to eventually discover that the information from the two sources is identical.

4.3 Modality Effect

All cognitive load effects discussed in the 1998 article assumed that working memory capacity is fixed for a given individual in the sense that the number of elements that could be dealt with was unalterable, with the modality effect as an exception. The modality effect is based on the assumption that working memory can be subdivided into partially independent processors, one dealing with verbal materials based on an auditory working memory and one dealing with diagrammatic/pictorial information based on a visual working memory. Consequently, effective working memory capacity can be increased by using both visual and auditory working memory rather than either processor alone.

5. Implication

For the development of learning instructions that save cognitive resources by optimizing information presentation and at the same time foster generative cognitive processing in accordance with the cognitive theory of multimedia learning, methods are required to identify cognitive load in relation to the corresponding cognitive processes. Furthermore, to determine the unique contribution of certain cognitive processes to different cognitive load aspects, it is important to answer significant theoretical questions concerning the model construction of CLT with different kinds of cognitive load and the interrelationship of the single cognitive load factors.

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