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Does the redundancy effect exist in electronic slideshow assisted lecturing?

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ABSTRACT

This study investigated the occurrence of the redundancy effect in a normal classroom when presenting multiple formats of information with the assistance of electronic slideshows. A virtual classroom that simulates a normal classroom was developed as the experimental platform in this study. One hundred and twenty undergraduates and graduated students were randomly assigned to the following three experimental conditions with varying presentation formats: audio only condition, visual only condition, and audiovisual condition. Test accuracy scores and cognitive load self-rating scales on both the recall and the comprehension tests were used to measure differences between various conditions. Analyses revealed a reverse audiovisual redundancy effect. For the recall test, the presentation of on-screen textual information accompanied by spoken narrations outperformed the presentation with the audio only source on test accuracy scores and indicated lower self-ratings of cognitive load. For the comprehension test, the presentation of on-screen textual information accompanied by spoken narrations outperformed the presentations with either of these two sources with higher test accuracy scores and lower cognitive load self-ratings. Classroom interference and segmented presentation were hypothesized to be two possible factors in determining the presence or absence of the redundancy effect.

1. Introduction

Electronic slideshows (e.g., PowerPoint) permit the presentation of multiple formats of information including texts, graphics, pictures, animation, and audio materials, terminating the age when the visual information can only be delivered with blackboard in traditional lectures. Projector and projection screen have been the most used teaching aids in normal classroom settings and their advantages were presented in many perspectives, such as being convenient for poor speakers, reducing complicated messages and elevating style over substances (Wright, 2009). However, limited studies focused on exploring whether using electronic slideshows in teaching could indeed be beneficial for the student learning and how the electronic slideshows should be used for benefiting the student learning.

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The processes involved in learning multiple sources of information associated with multimedia presentations are discussed by cognitive load theory (e.g., Kalyuga, 2012; Sweller, Ayres, & Kalyuga, 2011), which may relate to the effects of using electronic slideshows on learning as well as to the design principles for developing slideshow materials. Cognitive load theory (CLT) is an instructional design theory developed based on contemporary knowledge of human cognitive architecture that involves interrelated working memory and long term memory components when processing instructional information and constructing new knowledge (Sweller, 2010, 2011, 2012; Sweller et al., 2011; Van Merrienboer & Sweller, 2005). Cognitive load can be defined as the working memory resources that are used to achieve the goals of a learning task (Kalyuga, 2009).

There are two main types of cognitive load. *Intrinsic cognitive load* is determined by the complexity of learning elements in the subject domain that need to be processed for achieving specific instructional goals and by the learners with specific levels of prior knowledge. *Extraneous cognitive load* refers to the efforts required for processing unnecessary information and performing other cognitive activities that are irrelevant to achieving instructional goals due to poor instructional design (Kalyuga, 2012; Sweller, 2010). Being focused on the critical role of processing limitations of working memory in both capacity and duration, CLT suggests that any successful instructional design should control the total cognitive load within the working memory capacity. In recent years, instructional design principles based on CLT have been widely applied in designing digital teaching materials used in various technology-rich learning environments, such as mobile learning (e.g., Liu, Lin, Tsai, & Paas, 2012; Liu, Lin, & Paas, 2013; Liu, Lin, & Paas, 2014), computer assisted language learning (e.g., Liu, Fan, & Paas, 2014; Liu & Lin, 2011) and animations (e.g., De Koning, Tabbers, Rikers,& Paas, 2009, 2010, 2011). These principles are expected to be also used to direct the design of learning materials in the electronic slideshow assisted lecturing.

With the assistance of electronic slideshows, the instructional information can be delivered through both auditory and visual sensory modalities. In many cases, both modalities are used to present the same textual information simultaneously, possibly due to two reasons: (1) it is easy for teachers to copy and paste the instructional materials on the screen and just to read it aloud to the students during lectures, and (2) it is believed that presenting the same information in both modalities accommodates individual preferences of students who may choose to listen or to read (Kalyuga, 2012). Such a presentation format is widely used in normal classroom, however, violates the instructional design principle suggested by CLT, resulting in a redundancy effect. The redundancy effect is one of the cognitive load effects that has been demonstrated in many studies (e.g., Chandler & Sweller, 1991; Kalyuga, Chandler, & Sweller, 2004). It occurs when two or more of the presented sources of information could be understood separately on their own without the need of referring to other sources of information (Chandler & Sweller, 1991; Sweller, Van Merrienboer, & Paas, 1998). In this situation, presenting multiple sources of information that just re-describe each other may unnecessarily waste limited working memory resources on processing redundant information and thus impede learning. Some studies have demonstrated redundancy effects by using text-and-audio presentations. For example, Mayer, Heiser, and Lonn (2001) showed that the students who learned with text-and-audio presentations of science-related information performed worse than the students who learned with text- or audio-presentations. Using technical, text-based instructions without diagrams (Experiment 3), Kalyuga et al. (2004) also obtained this effect. Learning was facilitated when instructions were presented in spoken form alone rather than both spoken and written forms concurrently. The study of Jamet and Le Bohec (2007) found that the verbal redundancy effect occurred irrespectively whether the redundant written sentences that were accompanied by the identical spoken information were presented sequentially or together.

However, the redundancy effect has not been always demonstrated. Some studies in fact found a reverse redundancy effect. For example, Moreno and Mayer (2002) demonstrated that when no visual diagrams were involved, concurrent presentations of the same spoken and visual text resulted in better learning than spoken-only text. According to Kalyuga (2010), the length of instructional segments may be a significant factor in determining whether redundancy or reverse redundancy effect would occur. In Kalyuga et al.'s (2004) study demonstrating a redundancy effect, the text was presented to participants continuously as a single large chunk of around 350 words without breaks. In contrast, the text used in Moreno and Mayer (2002) study was presented in several consecutive small segments with appropriate breaks between them. Such breaks may have allowed the learners to consolidate their partial mental models constructed from each segment of the text before moving to the next one, thus decreasing the cognitive load and resulting in a reverse redundancy effect.

Although the redundancy effect as a result of presenting the same information in two different modalities have been demonstrated in many empirical studies, most of the studies were conducted in well-controlled laboratory settings or carried out with the participants individually. Both these environments are quite different from the normal classroom in real educational settings. Electronic slideshow assisted lecturing in a normal classroom has two main typical features. First, the information is usually segmented into several sections rather than presented continuously due to the low resolution and limited space typical to the commonly used electronic slideshows. Second, the classmates sitting around may potentially create some sources of interference. In this situation, an important question related to successful use of electronic slideshows in a normal classroom is whether the characteristics of such slideshows would influence the occurrence of the redundancy effect or, in other words, whether the redundancy effect observed in the experimental environments could also be applicable in normal classrooms.

The current study was aimed at exploring this question by examining the occurrence of the redundancy effect in a real, normal classroom environment when presenting multiple formats of information with the assistance of electronic slideshows. The hypothesis tested in the current study was based on the conditions for producing the audiovisual redundancy effect and the features of electronic slideshow assisted lecturing in normal classrooms. Redundancy effect occurs when learners simultaneously process similar information from different sources and this information is characterized by