Developing Multimedia Text for Reading Comprehension Based on Cognitive Theory of Multimedia Teaching

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Abstract- This research discuss how to develop multimedia text for reading comprehension based on mayer’s cognitive theory of multimedia teaching (Mayer, 2010) and cognitive processes underlying text comprehension for Verhoeven and Perfetti (2008). Using both theories, the researcher develop a multimedia reading comprehension text to increase students’ ability to comprehend the reading text.

Keywords: Reading Text; Cognitive Theory of Multimedia Learning; Cognitive Processes Underlying Text Comprehension.

1. INTRODUCTION

According to the National Council for Accreditation of Teacher Education (NCATE, 1997), the current issues not about using technology in education or ignoring it, but it is about how to employ this technology in the teaching and learning process in a proper way (National Council for Accreditation of Teacher Education (NCATE), 1997). The fact that the use of technology has become a reality cannot be ignored (Guemide & Benachaiba, 2012).

Verhoeven and Perfetti (2008) looked at on ways to model multimedia text and how to practically present it to allow students to achieve it and improve their reading comprehension through the use of multimedia text.

A Cognitive Theory of Multimedia learning Implication for Design Principles- From 1979 to 2010, Richard Mayer carried out several studies on a theory of multimedia learning and provided an approach to designing multimedia. Mayer and Merlin (2010) stated that the instructional technology researchers are focusing on the cognitive processes which take place inside the student to present content corresponding to his mental processing of knowledge, and to have the new knowledge linked with the prior knowledge. According to Richard Mayer (1979, 2010), there are various principles in multimedia learning theory. They are as follows:

Modality Principle- It is better to present an explanation using two models (words and pictures) representation rather than one. Mayer and Gallini (1990) proved that students who read a text with illustration placed near the corresponding words were 65% more successful
in subsequent problem solvings and transferring their knowledge than students who simply read a text without illustrations.

**Contiguity Principle**- It is better to give a multimedia explanation by presenting the words and pictures at the same time rather than separate in time. Mayer, Steinhoff, Bower and Mars (1995) proved that students who read a text with illustrations placed near the corresponding words were 75% more successful on problem solving transfer test than did those students who read the same text and illustration which were presented on separate pages.

**Split –Attention Principle**- It is better to give a multimedia illustration by presenting the words via auditory narration rather than by just visual on screen text. Mayer and Moreno (1998) confirmed that students who watched an animation while also listening to a corresponding narration were 50% more successful in providing solutions to a problem-solving transfer test than did students who watched an animation without listening to a corresponding narration. Aldalalah and Fong (2010) also reported that the students who read a text with audio is better than text with image.

**Coherence Principle**- Using few rather than many extraneous words and pictures is better. Mayer and Anderson (1992) pointed out that students using coherence multimedia illustration performed better on a subsequent problem-solving transfer test than did students who read the same information with additional details inserted in the materials.

Mayer (2009) explained a cognitive model of multimedia learning to explain the human information processing based on three basic assumptions: the dual channel assumptions, limited capacity assumptions and active processing assumptions.

**The dual channel assumption**- Based on the working memory model by Baddeley (2000), the human cognitive system is divided into two different channels for representing and handling knowledge — pictorial and verbal channels. Pictorial channel enters the cognitive system via the eyes such as images and written text. Verbal channel enters the cognitive system via the ears such as audio illustration, audio narrative and animation.

**Limited capacity assumption**- Based on Each Sweller’s cognitive load theory and Baddeley’s working memory model, each channel in the human cognitive system has a limited capacity for holding and manipulating knowledge. To illustrate, when we present a lot of pictures (or other visual materials) at one time, the visual-pictorial channel can become overloaded. Furthermore, when we present a lot of spoken words (and other sounds) at one time, the auditory-verbal channel can become overloaded.

**Active processing assumption**- Mayer (2010) stated that meaningful learning occurs when students engage in active processing within the channels. Meaningful learning occurs through selecting suitable words and pictures, organizing them into coherent pictorial and verbal models, and integrating them with each other based on appropriate prior knowledge. These active learning processes occur when corresponding verbal and pictorial representations are in working memory simultaneously.

Based on these, Mayer (2010) divided human memory into three frames as shown in Figure 1 (Store Sensory, Working and Long-term memory). Multimedia presentation (Pictures and Words) enters sensory memory through the eyes and ears. Then the sensory memory allows multimedia presentation (Pictures and Words) to be held as exact visual images and auditory images for a very brief period in the visual and auditory sensory memory. The essential work of multimedia learning occurs in the working memory where it
selects images and sound, organizes them and integrates them. Long-term memory allows the students to store a large amount of knowledge over a long period of time. The learners represent an active agent in the learning process via multimedia through these three processes: selecting, organization and integration.

**Fig. 1. Mayer’s Cognitive Theory of Multimedia learning** (Mayer, 2010)

**Modeling text comprehension processes based on Mayer’s Cognitive Theory of Multimedia learning**- Earlier, Perfetti (1999) suggested that reading comprehension occur based on student’s knowledge. To illustrate, Prefetti stated that the reading comprehension process starts with the identification of individual words; i.e., by converting the visual input into a linguistic representation, followed by a comprehension of any text that requires word-to-text integrating.

**Fig. 2. Model of the reading comprehension process** (Perfetti, 1999).
Consequently, Verhoeven and Perfetti (2008) affirmed that readers construct situation models as they attempt to comprehend text. They observed that there are two levels of representation—a model of the propositions of the text (the text model) and a model of what the text is about (the situation model). Furthermore, Verhoeven and Perfetti added that comprehending the texts cannot be fully clear, so the reader makes inferences about what is in the text based on prior knowledge.

Mayer (2009) asserted that multimedia presentation offers many possibilities to facilitate knowledge construction. Likewise, Verhoeven and Perfetti (2008) suggested that researchers had to examine how students learn from multimedia text, especially now that ICT is progressively being integrated into the school curriculum. The concentration of instruction of school subjects and networked technologies appears unavoidable.

The cognitive theory of multimedia learning (Mayer, 2009) was founded on the idea that there are different processing systems for the two kinds of information, and that these channels show a limited processing capacity. According to Verhoeven and Perfetti (2008), the components which are mixed up in the multimedia cognitive theory offer opportunities to facilitate teaching and learning comprehension. They further stated that the processing of verbal information normally includes the comprehension of written text, which can be viewed as a secondary language process partly obtained from primary spoken language processes, or audio or verbal illustration of words. They added that the processing of pictorial information normally includes written text or images.

![Modelling multimedia text processing (Verhoeven & Perfetti, 2008).](image-url)

According to Mayer (2001, 2005, 2010), various multimedia presentations offer the opportunity for students to use words and pictures. Words refer to printed text or spoken text. Pictures refer to drawing, charts, graphics, maps, photos, animations and videos. Mayer (2010) stated that using words and pictures is better than using words alone. The students’ comprehend better when watching and listening, than when watching alone (Mayer & Mereno, 1998). In brief, multimedia is able to increase the student’s reading comprehension achievement.

Similarly, Verhoeven and Perfetti (2008) observed that the fundamental models of text comprehension, such as the resonance model (Gerrig & McKoon, 1998), the construction integration model (Kintsch, 1988) and the landscape model (Van den Broek, Risden, Fletcher, & Thurlow, 1996), have shown that text comprehension cannot be achieved with only the information that is present in the text. The learners should also use their knowledge to construct new knowledge, which is relevant to learners’ experience and situation. Verhoeven and Perfetti (2008) also explained that the components which are mixed up in multimodal text processing allow the learner to make inferences about what is in the text based on their prior knowledge.

Son (2003) conducted a study to investigate the effect of three different types of reading text formats, namely paper-based format (PF), computer based non-hypertext format (NHF), and computer-based hypertext format (HF). The study aimed to find out the degree of usefulness of hyperlinks on the online lexical resources, which provide readers with optional assistance during independent reading. The finding showed that the integration of text with sound and images eventually paves the way for greater comprehension of the reading text, as well as better pronunciation and contextual use of lexical items in a way that Instructional paper-based texts cannot achieve.

Similarly, Kuo, Yang, and Kuo (2010) conducted a study to investigate the effect of multimedia, specifically the Reading Comprehend (RC) Platform, on student’s reading comprehension. RC Platform focuses on the integration of various multimedia. The participants were two classes of fourth graders from a public elementary school in an urban area of central Taiwan. The result showed that the students displayed a high interest in the RC Platform and had also gained great benefits on reading comprehension via the technology-enhanced project within the RC Platform. Hence, the researcher concluded that the Platform enhanced students’ performance in English reading comprehension and he called for further research to investigate other types of multimedia that can affect student’s reading comprehension.

Segers and Hulstijn-Hendrikse (2008) investigated the effect of the cognitive processes underlying multimedia text learning among students in basic schools. The students were taught reading comprehension lessons by using different formats: in written presentation only which is accompanied by pictures, oral presentation only and oral presentation accompanied by pictures. The finding showed that students using oral presentation with pictures performed better than students using written presentation accompanied by pictures.

2. MULTIMEDIA TEXT FOR READING COMPREHENSION

Theoretical framework of this research drew from Mayer’s (2010) cognitive theory of multimedia learning and cognitive processes underlying text comprehension for Verhoeven and Perfetti (2008). The researcher applied these theories in reading comprehension in the Arabic language.
According to Mayer’s (2010) cognitive theory of multimedia learning, the students using AL1WBT engaged in active processing within the channels (visual and the auditory channel). A meaningful learning occurs when students select suitable words and pictures, organize them into coherent pictorial and verbal models, and integrate them with each other and appropriate prior knowledge. Mayer (2010) stated that these active learning processes can occur when corresponding verbal and pictorial representation are in working memory at the same time. In addition, Mayer (2010) showed that when information presented is similar to cognitive processes which occur inside the learner, the learner will learn better and that helps him to gain information retention and storage in the long-term memory.

Verhoeven and Perfetti (2008) pointed out that the students cannot comprehend the text comprehension with only the information presented in the text, but that students also use their prior knowledge to construct new knowledge. During this process, the reader involve two levels of representation — the text model, a model of the propositions of the text, and the situation model which is a model of what the text is about. Verhoeven and Perfetti’s (2008) suggested that readers who have other sources of information read more comprehensively than readers using only the printed text. According to Multimodal text processing, the students using text model and pictorial model are expected to read more comprehensively than students who use the text model.

Based on the above, the researcher suggests the lessons in reading comprehension using multimedia presentation. Students using Multimedia reading text are taught reading comprehension by using two models (verbal and pictorial model), and students using normal reading text are taught reading comprehension by using one model (pictorial model). Figure 4 explains the two teaching methods used in this study.

![Multimedia Reading Text](image1)

![Normal Reading Text](image2)

*Fig.4. Multimedia Reading Comprehension Text*
Figure 4 showed that a possible reason for the significantly positive effect of multimedia text on students’ reading comprehension achievement can be explained by Mayer’s (2010) cognitive theory of multimedia learning and cognitive processes underlying text comprehension for Verhoeven and Perfetti (2008). The cognitive theory of multimedia learning proposed that the human information processing system comprises dual channels, that is, one for visual processing and the other for auditory processing. When information is presented to the eye (text), learners begin by processing that information in the visual channel; when information is presented to the ears (audio), learners begin by processing that information in the auditory channel. Thus, Verhoeven and Perfetti (2008) suggested that the students read comprehensively when information is presented in the two channels — visual and the auditory channels.

The modality principle may effect on the students’ reading comprehension achievement. According to the modality principle, the students who read a text with an illustration placed near the corresponding words were better than students who simply read text without any illustration (Mayer & Gallini, 1990). Each word on the multimedia text has illustration where the students can click on the word as the illustration appeared. On the other hand, the reading text for students using the normal reading text was without an illustration.

Furthermore, normal reading text competed for limited cognitive resources in the auditory channel because the student in the normal reading text has just the written text and illustration without the audio narrative. Both written text and illustration enter the information processing channel through the eyes. In such a condition, visual image, together with the printed written text, may result in an overload in the visual channel, while the auditory channel remained unused. This affected the processing of information. Furthermore, a student using normal reading text (written illustration and printed text) has to split their attention between the two information sources (Mayer, 2005). The student in the normal reading text has to switch their attention back and forth between the written illustration and the printed text. This involved much cognitive load to process the switching.

Finally, Verhoeven and Perfetti (2008) claimed that the Multimodal text increased students’ reading comprehension achievement. The Multimodal text is where the students read more comprehensively from multimodal than one model (Verhoeven & Perfetti, 2008). According to the cognitive theory of multimedia learning, the meaningful learning occurs when students engaged in active processing within two channels (Mayer, 2009). Thus, the students using the multimedia text may read more comprehensively compared to the students using normal reading comprehension text.

3. CONCLUSION

This study suggested developing multimedia text for reading comprehension by using Mayer’s cognitive theory of multimedia teaching (Mayer, 2010) and cognitive processes underlying text comprehension for Verhoeven and Perfetti (2008). This study suggested that students who use both channels (verbal and pictorial) in reading comprehension text will increase students’ achievement in reading comprehension. Finally, the researcher develop reading comprehension text based on Mayer’s cognitive theory of multimedia teaching (Mayer, 2010) and cognitive processes underlying text comprehension for Verhoeven and Perfetti (2008).
4. REFERENCES


