Effects of Redundancy and Modality Principle in Multimedia Learning: Concentration on Motivation and Gender Differences among Primary School Students.

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Abstract

This aim of this study is to examine the impact of on-screen text on the learning performance of grammar learning of Bahasa Malaysia involving a group of primary schoolers. In addition, learners' characteristics such as motivation and gender were also examined in this study. It was hypothesized that learners who had received redundant text explanation and animation would perform worse on memory and problem solving test. Results showed that the redundancy learning mode that integrates animation, sound narration and on-screen text in a computer-based environment helped improve students' performance. This finding suggests that on-screen text could reduce cognitive load and enhance learning process, which leads to better performance.

Keywords redundancy principle, modality principle, animation, multimedia instruction.

INTRODUCTION

In multimedia learning, information is presented to students with a combination of different modalities or modes such as spoken words and pictures. Mode refers to the format used to represent the lesson, such as words versus pictures. Modality refers to the information-processing channel used by the learner to process the information, such as auditory versus visual. The purpose of this study was to investigate whether the addition of on-screen text would promote the learning of a narrated Bahasa Malaysia grammar within multimedia learning environments among primary school students. Of particular interest for the previous study was how specific combinations of modes and modalities

may affect students' learning of language explanations, such as when visual and auditory verbal materials (i.e., on-screen text and narration) are combined with visual and auditory nonverbal materials (i.e., animation and sounds). Therefore, text redundancy was a subclass of redundant information, in general, which also included the cases where verbal and nonverbal materials were used to represent the same information in different modes. The impacts of different media presentation modes on learning remain inconclusive.

However, Kalyuga *et al.* suggested that some multimedia learning software can lead to cognitive overload, which affects learning performance negatively. Unnecessary or repeated multimedia messages can result in a redundancy effect, which negatively affects learning performance. Multimedia helps learners learn, but different media presentation modes affect learners' cognitive load differently. The purpose of instructional design is to assist learners to store information in long term memory. This implies that the way teaching materials presented to learners is a key element in instructional design. Attention to cognitive load is a critical concern for instructional designers when designing multimedia teaching materials, because unnecessary multimedia messages may worsen learning performance by increasing working memory load and interrupting information processing.

CONTEXT

Multimedia instructional systems have been widely applied in teaching and learning, but the media presentation mode that is best for English listening comprehension remains uncertain, and whether unnecessary information leading to cognitive overload for the learners also remains inconclusive. Students who learn with double mode (sound and text) out performed students who learn with single mode (sound) and had lower cognitive load. This study examines the effects of redundant text on animation in multimedia learning environment among primary school students. Specifically, the purposes of this study are as the following:

1. Examine whether redundant text improves learning performance when presented with grammar learning content. It is hypothesized that learners who receive redundant text explanation and animation will perform worse on memory and problem solving test. Diao and Sweller conducted a redundancy study in language learning where they examined the students' lexical abilities and the level of text comprehension in two-group settings: written and spoken text presentation, and written presentation only. The redundant group under performed in both the comprehensive level and the lexical level to the written only presentation group. A negative redundant effect was observed. The effects of redundancy need to be further tested when redundant texts are used together with narration and visual. Kalyuga *et al.* demonstrated in three experiments that presenting on-

screen text that is read aloud by a narrator creates a redundancy effect, causes an overload in cognitive processing, and, as a result, produces lower student test scores. However, other studies reported increases in student learning when animation was presented with auditory and written texts simultaneously. The redundant text may enhance learning when animation and redundant text are presented sequentially. The effect of redundancy needs to be further tested among children when animation and redundant text are used for learning, and tested whether the learning outcome will be different in gender. Based on previous studies, it shows that genders are learning with different style and this result is worthy of future research. Chanlin suggested that males are more sensitively and pay more attention to visual such as graphic, images, and etc. than females. Another study in which provides that there is gender differences in perceptions of visual stimuli. Males have more positive attitude toward computer learning than females in visual learning.

2. To further examine the effects of redundant text by combining animated materials as an instructional feature with redundant text, which has yet to be conducted. Furthermore, learner characteristics such as levels of motivation and genders are the factors to include in this study.

THEORETICAL FRAMEWORK

This study applied the Cognitive Theory of Multimedia Learning to investigate the effects of redundancy learning mode and modality learning mode. This model is adapted from Mayer to explain the connection between verbal and visual modes in each representation. A multimedia instructional presentation is the way of communication that involves words and pictures to foster learning. The two main formats in multimedia learning are words and pictures. Words are presented in speech and printed text; and pictures are presented in static picture (illustrations or photos) and dynamic graphics (animation and videos). The term multimedia learning can be explained by three views of multimedia instruction: (i) the delivery-media view, (ii) the presentation-modes view and (iii) the sensory-modality view. The presentation mode and sensory modality are two different kinds of multimedia instruction. The presentation mode view emphasizes that instruction should include two presentation format (verbal and pictorial) to present the material. And the sensory modality view emphasizes that two sensory systems (auditory and visual senses) in the learner are involved. The cognitive theory of multimedia learning (CTML) mentioned on an idea that learners attempt to build meaningful connections between words and pictures and that they learn more deeply than they could have with words or pictures alone. There is the combination of two presentation format and two sensory systems in multimedia instruction. This called adding redundant on-screen text together with narration and graphics. When pictures, printed words, and spoken words are all presented together, the sensory system will

become overloaded and produce extraneous processing in two ways. Students learning will be affected if the text is presented or added to a multimedia presentation, because the text is redundant the same information that has been been presented via other sources.

PROCEDURE

One hundred and eight standard three students in public primary Chinese school made up the sample for this study. All students had attended Bahasa Melayu class and had some basic understanding on different type of nouns. Participants are randomly assigned to two conditions with different versions of learning mode, 54 students had to learn with sound narration and animation (modality learning mode) and 54 students had to learn with sound narration , animation and on screen text (redundancy learning group). Students will be assigned to computer laboratories that could accommodate an entire class of up to 25 students at one time.

This experiment was conducted in a computer-based learning environment. All students took part in the experiment. This study is an experimental design with independent measures. The independent variables were the learning modes (redundancy group and modality group). The dependent variables were gender (male and female students) and the motivation towards the instructional modes (as measured by Keller's IMMS questionnaire). This experimental were using a one-way ANOVA to analyze the interaction between the two independent variables on the dependent variable. In this study, one-way ANOVA was used to understand whether test performance differed based on multimedia instructions among primary school students. Students are divided into two independent groups (redundancy and modality learning group).

1. Pretest Phase
   A prior knowledge test was administrated to determine the participants' prior knowledge of the topic of nouns. This pretest contained 14 questions.

2. Intervention Phase
   Immediately after the students had completed the pretest; they were given the version of the presentation mode that corresponded to the experimental condition they were assigned to. Students in all the two presentation modes were exposed to the same instructional materials but in different modes of presentation. Students in the redundancy mode were asked to learn the nouns by watching the short animation (illustration, narration and on-screen text) on the computer. The learning environment for the students in the modality mode was exactly the same as redundancy mode, except the animation content on the computer only consisted of illustration and narration. Students can control the presentation of the computer-based learning material by using computer's mouse.

3. Post Test
    Immediately after the students completed the learning activity, they were asked to complete a test to assess their understanding of nouns. This posttest contained 15 questions.

There were two instruments in this study, (i) the Bahasa Melayu nouns pre-test and post test questions (each comprising of 14 questions and 15 questions from the domain of understanding and distinguish the type of nouns), and (ii) the Instructional Material Motivation Scale (IMMS) to measure the learners' motivation towards the learning modes. The pre-test questions were developed to determine the learners' understanding and analytical abilities of the Bahasa Melayu nouns in Year Three level. And the post-test required students to read through the comprehension passage and write down the answers according to the type of the nouns. The post-tests are divided into two parts, part A required students to read through the comprehension passage and write down the answers according to the type of the nouns (8 questions). And part B required students to underline the most suitable common nouns (7 questions). The Instructional Material Motivation Scale (IMMS) was developed to measure the learners' motivation towards the modes of instruction. In this study, the original Likert-type choices will be changed to emoticon which is much more suitable for students. The IMMS questionnaire will be comprised of 36 emoticon statements (adapted version) that are based on four components of ARCS model: Attention, Relevance, Confidence and Satisfaction.

RESULTS

The goals of this experiment were to investigate the effects of redundancy learning mode (i.e., animation, narration and on-screen text) and modality learning mode (i.e., animation and narration only) on the learning of Bahasa Malaysia as second language among primary Chinese school students. The following null hypotheses were formulated and tested at the 0.05 level of significance.

Hypothesis 1: There is no significant difference between students' motivation in Redundancy Learning Mode and Modality Learning Mode.

Hypothesis 2: There is no significant difference between students' test scores in Redundancy Learning Mode and Modality Learning Mode.

Hypothesis 3: There is no significant difference between female students and male students in terms of their motivation levels in Redundancy Learning Mode and Modality Learning Mode.

A. *Effects of Redundancy Mode and Modality Mode on students' perceived motivation. (Null hypothesis 1)*

Table 1 presents the results of Mann-Whitney U test that there was a significant difference between the two learning modes (redundancy and modality) on the student's perceived motivation (U = 894.000, Z = -3.469, p = 0.001). This means

that the learning mode had a significant main effect on student's perceived motivation. Students in redundancy learning mode (mean rank = 64.94, sum of ranks = 3507.00, $p = 0.001$) were significantly more motivated than students in the modality learning mode (mean rank = 44.06, sum of ranks = 2379.00, $p = 0.001$). In this data analysis, Mann-Whitney U test was used to examine whether learning mode toward test scores will be different between the two groups of students.

Table 1 Mann-Whitney U Test of IMMS Score by Learning Mode

Learning Mode	IMMS Score					
	N	Mean Rank	Sum of Ranks	*M-WU*	Z	Sig
Redundancy	54	64.94	3507.00	894.0	-3.469	0.001
Modality	54	44.06	2379.00	0		

B. *Effects of Redundancy Mode and Modality Mode on students' gain score (Null hypothesis 2)*

There was a statistically significant difference between groups as determined by one-way ANOVA (F (1,106) = 13.483, $p = 0.000$). This means that the learning mode had a mean effect on gain score. Students in redundancy learning mode (mean = 2.870, SD = 1.182, $p = 0.000$) significantly performed better and gain more scores than students in the modality learning mode (mean = 2.055, SD = 1.122, $p = 0.000$). The mean gain test scores, the standard deviation, standard error and the number of learners of the two learning modes are summarized in Table 2.

Table 2 Number of Learners, Means, Standard Deviations, Lower Bound and Upper Bound in 95% Confidence Interval of Mean and Standard Error of Gain Score by Learning Mode

Learning Modes	Gain Score					
				95% Confidence Interval Mean		
	N	Mean	SD	Lower Bound	Upper Bound	SE
Redundancy	54	2.870	1.182	2.547	3.193	0.160
Modality	54	2.055	1.122	1.749	2.362	0.152
Total	108	2.463	1.218	2.230	2.695	0.117

The effect size of the redundancy learning mode and the modality learning mode was also examined because there was a significant difference between the two modes. The results showed that the effect size of redundancy learning mode in relation to modality learning mode was 0.3359, which is considered to be a small effect size.

C. *Effects of Redundancy Mode and Modality Mode on students' gender and perceived motivation (Null hypothesis 3)*

Table 3 presents the number of learners, means of IMMS score, standard deviations and standard errors for male and female students in the two learning modes (i.e., redundancy and modality). Values of standard deviations for learners in redundancy learning mode and modality learning mode were (SD = 4.953) and (SD = 6.735), respectively. A one-way analysis of variance (ANOVA), the mean of IMMS score between the male and female students in the two learning mode was performed. The result of ANOVA revealed that there were significant differences between the male and female students across the two learning modes based on the means of IMMS scores. The F ratio of IMMS score in redundancy learning mode (1, 52) was 187.061 ($p < 0.05$). This means that gender had an impact on the IMMS score based on the learning mode. Female students (mean = 124.888, SD= 4.492, p=0. 000) were significantly more motivated than male students in the redundancy learning mode. The F ratio of IMMS score in the modality learning mode (1, 52) was 15.813 ($p < 0.05$). Male students (mean = 111.481, SD = 5.308, p = 0.000) were significantly more motivated than female students in the modality learning mode.

Table 3 Number of Learners, Means, Standard Deviations and Standard Error of IMMSScore and Gender by Learning Mode

Redundancy Learning Mode			
Gender	IMMS Score		
	N	*M*	*SD*	*SE*
Male	27	106.370	5.414	1.042
Female	27	124.888	4.492	0.864
Total	54	115.629	4.953	0.953
Modality Learning Mode			
Gender	IMMS Score		
	N	*M*	*SD*	*SE*
Male	27	111.481	5.308	1.021
Female	27	105.037	6.536	1.258
Total	54	108.259	6.735	0.961

DISCUSSION

The study was carried out to investigate the effects of redundancy learning mode and modality learning mode on (1) students' perceived motivation, (2) students' gain score, (3) students' perceived motivation of multimedia learning based on gender.

A. Effects of Redundancy Learning Mode and Modality Learning Mode on students' perceived motivation

Students in redundancy learning mode had a significantly higher perceived motivation than students in the modality learning mode towards the instructional multimedia learning; hence, the first research hypothesis is not supported. The findings are in line with existing research and practice that have claimed that learning with proper and attractive instructional multimedia learning will enhance the learning process and reduced cognitive load. Learners who are exposed to redundancy learning mode learn more and more motivated to learn and pay attention when learning something especially on language learning. The findings support the claims that embedding instructional strategies into learning can enhance cognitive procedure and motivation. When learners receive the learning material with add-on screen text, they become more aware about the learning content and become more satisfied and comfortable. This will indirectly increase their motivation. This could be related to the effect of on-screen text that captures student's attention.

On-screen text plays an important part in maintaining the learners' attention to the instructional learning material. The results are consistent with other research findings, which have indicated that learners' learned and adapted well using cognitive strategies such as on-screen text to improve learning and to improve academic performance. In the redundancy learning mode, the on-screen text plays an important role to keep learner's attention and raises their motivation to learn and to keep them remain focused on the material. Meanwhile, there is no add-on screen text in the modality learning mode, which can attenuate learners' attention toward multimedia learning. Modality learning mode only presents instructional material with static pictures and audio narration. Additionally, the addition of on-screen text to informative narration using animation tends to maintain learners' attention and interest in multimedia learning.

This finding is similar to the findings of Toh *et al.*, who conducted a study regarding the effects of different learning modes (redundancy and modality) on student's perceived motivation in learning. The learners in redundancy learning mode (with redundant textual information) had a significantly higher perceived motivation than students in the modality learning mode (without redundant textual information). In this study, the redundant on-screen text cue the student's attention to learning. An experimental study tests the effects of four type multimedia-based instructions. The four types of multimedia instruction were multimedia-based instruction with relevance strategies, multimedia-based instruction with no ARCS strategies, multimedia-based instruction with attention strategies and final multimedia-based instruction with both attention and relevance strategies. Among the four types of multimedia-based instructions, the results show that the multimedia instruction with attention strategies can directly increase learners' motivation to learn.

B. *Effects of Redundancy Mode and Modality Mode on students' gain score*

In this study, there was a significant difference in gain scores between redundancy learning mode and modality learning mode; thus, the second research hypothesis is not supported. The reason for this difference is that students might have faced difficulties when listening to audio narration in a second language, where relevant information could not be acquired and understood properly. On the other hand, the learners in the redundancy learning mode performed well because the on-screen text helped them in understanding the spoken words, thus achieving the three aspects of active learning – the process of selecting, organizing and integrating the knowledge was performed during the learning process. The results were supported by the findings by Adegoke which showed that students in animation, narration and the on-screen text group had the highest post mean scores on achievement test and interest. According to cognitive theory of multimedia learning, meaningful learning will only occur when learners can relate the learning to relevant portions of the incoming visual and auditory information, organize the incoming material into the separate verbal and pictorial channel, and integrate the two different representations. Learners in the redundancy learning mode will not cause cognitive overload and this will reduce extraneous processing in multimedia learning. The on-screen text might help learners recognize the Bahasa Malaysia words easier and prevent from overload thinking about the presented information.

C. *Effects of Redundancy Mode and Modality Mode on students' gender and perceived motivation toward multimedia learning*

This study showed that different gender (i.e., male and female) in the redundancy learning mode and the modality learning mode had a significant difference in perceived motivation towards the multimedia learning. This means that the third research hypothesis is not supported. Furthermore, female students in the redundancy learning mode had significant positive attitude on perceived motivation toward multimedia learning than male students. In addition, male students in the modality learning mode had significant positive attitude on perceived motivation toward multimedia learning than female students. In some research, male and female participants have demonstrated different mental abilities such as spatial and verbal ability. These differences in mental ability may partly explain why female students in the redundancy learning mode performed slightly better than male students, and male students in the modality learning mode performed slightly better than female students. Furthermore, previous research findings sugggest that females usually perform better than males in verbal ability test that may explain why female students in the redundancy learning mode (i.e., with on-screen text) gained higher test scores by paying more attention in the multimedia learning. In contrast, male students have been observed to perform better than female students in spatial

ability tests (Halpern, 2004). Thus, the difference in spatial ability, which favors males, may explain why male students in the modality group who learned by listening to audio narration without referring to on-screen text demonstrated higher positive attitude toward multimedia learning. In the verbal-based component of the IQ test, females outperformed than males, suggesting thatt females are more effective in processing verbal information than males. The gender difference that has been found in this research strongly suggest that gender factor needs to be taken into account when designing multimedia learning applications given the inherent differences in mental abilities between males and females.

CONCLUSION

This study has shown that the redundancy learning mode that integrates animation, sound narration and on-screen text in a computer-based environment helped improve students' performance. More specifically, the on-screen text could reduce the cognitive load and enhance learning performance by making the recall of the knowledge in the long term memory more efficiently. Students who had learned Bahasa Malaysia in the computer-based environment achieved a better learning outcome. Four limitations of the current study should be noted for future research and development. First, the small sample size of learners in this study may have contributed to non-significant findings on some specific measures, which could not represent the majority of the target group. Second, learners' performances were measured immediately after the experiment where some students might be subjected to cognitive overload, which affected their performance. Thus, measurements of performance in future studies should be conducted under delayed conditions. Third, due to the unpredictable learners' behavior, it was necessary to provide the instructions clearly so that no learners would be confused with the process of the experiment. Future research should use some form of guidelines of the correct teaching method to avoid any biases. Finally, the post test questions in this study might be related to some students' prior knowledge, which made the students very familiar with the solutions. For future research, the test questions can be designed based on the content of instructional multimedia to directly measure students' performance. In future research, the comparison between redundancy principle and modality principle with different learning-based environments, such as traditional learning and multimedia learning, can be explored. In addition, the effects of text on multimedia presentation can be examined based on the synchronization and non-synchronization of the multimedia elements.

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