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READING AUTHENTIC EFL TEXT USING VISUALIZATION AND ADVANCE ORGANIZERS IN A MULTIMEDIA LEARNING ENVIRONMENT

Huifen Lin
Tsuiping Chen
Applied English Department
Kun Shan University, Taiwan

The purpose of this experimental study was to compare the effects of different types of computer-generated visuals (static versus animated) and advance organizers (descriptive versus question) in enhancing comprehension and retention of a content-based lesson for learning English as a Foreign Language (EFL). Additionally, the study investigated the interactive effect of students' existing reading proficiency level and the above-mentioned treatments on their reading comprehension achievement. Students from two EFL reading sections (N = 115) were tested on their reading proficiency and then randomly assigned to one of four computer-based instructional modules—static visual alone, animation alone, animation plus descriptive advance organizer, and animation plus question advance organizer. Once having interacted with their respective instructional materials, students then took four criterion tests immediately afterward and again four weeks later. The results showed that the animation group outperformed the static visual group in one of the four tests, and that animation embedded with a question advance organizer had a marginal effect among the four treatments in facilitating the acquisition of L2 reading comprehension both for the immediate and the delayed posttests.

INTRODUCTION

Instructional materials designed and developed using multimedia have provided exciting potential learning opportunities thanks to advancement in information technology, making their pedagogical effects on learning and teaching worth examining. L1 reading comprehension takes place when a previous acquired schema stored in the long-term memory is retrieved to assist the processing and understanding of new unfamiliar information (Anderson & Pearson, 1984). The process of transforming incoming information/knowledge elements into schemata requires considerable cognitive mental effort. Native language speakers typically encounter difficulties in reading when they have gaps in their content knowledge. However, the problems faced by L1 readers can also be applied to L2 readers. Insufficient background knowledge hinders top-down processing of the new information, and limited language competence of second/foreign language learners makes the decoding process even more difficult. For ESL/EFL learners with low prior knowledge of a subject matter, instructional strategies need to be integrated into the course material. Instructional materials developed using multimedia are believed to be able to facilitate learners' information processing, and to enhance effective cognitive encoding due to the multiple representations that trigger both verbal and visual modes of processing in human beings.

LITERATURE REVIEW

Theoretical Framework

Dual-coding theory (Paivio 1971, 1978, 1990, 1991) provides theoretical justifications for the use of visuals in the instructional presentations. According to the dual-coding theory, human memory is composed of two independent but interconnected coding systems. The visual system primarily deals with visual codes, such as images, pictures, concrete objects, or events; the other system, the verbal system,

deals with non-visual codes such as words, speech, language, or semantic codes. Generally, each of the systems functions independently but most information processing requires connections and reinforcement between the two systems (Lai, 2000). Generally speaking, visuals are more likely to be processed in both verbal and visual systems, and hence the probability that they are retained in working memory and retrieved later from long-term memory is higher than when the presentation contains verbal information alone (Kobayashi, 1986).

Mayer (1994) developed a generative theory of multimedia learning to provide design principles of multimedia instructional materials. The basic tenet of the generative theory of multimedia learning is that learners actively construct knowledge and are involved in a meaningful learning process. A meaningful process occurs when learners consciously select information from presented stimuli, organize information into coherent representations, and then make efforts to integrate new information with other information. The step of integration of information from two individual systems, i.e. verbal and visual, is especially critical. For a successful integration process to occur, both verbal and its corresponding visual information must be held in the working memory simultaneously.

Advance Organizers and Meaningful Learning

An advance organizer is defined as an instructional unit that is introduced in advance of direct instruction. It is generally presented at a higher level of abstraction and is intended to connect learners' prior knowledge to what they will learn (Ausubel, 1963). According to Ausubel, for meaningful learning to occur, learners must possess a meaningful learning set and the material must be meaningful to them. The learning set refers to an existing cognitive structure that contains components to which the learner can connect substantive and relevant features of new information and thus draw various relationships between existing knowledge and newly acquired information. Kloster and Winne (1989) suggest that advance organizers may promote learning because they "…supply a learner with a new cognitive structure so that the new information can be connected to it…" and that advance organizers "…cue students to assemble links between new information and more abstract, general, and inconclusive information that the students already know…" (p. 9). An advance organizer is designed to give learners a general overview of the new material before the actual confrontation, and it creates a cognitive connection between established knowledge and new material in terms of the relevant concepts, therefore enhanceing the "familiarity and learn-ability of new material…"(Ausubel, 1963, p. 82).

Research findings have provided evidence of the superior effects of various types of advance organizers used to facilitate reading comprehension. Evans (2003) investigated the effects of graphic organizers, one type of advance organizers for Japanese readers on expository texts in English and found that student-generated graphic organizers help accommodate different learner styles, lead to meaningful learning, and enhance reading comprehension. In their study looking into how the use of a dynamic visual advance organizer can facilitate reading comprehension of L2 learners, Chun and Plass (1996) indicated that a dynamic visual advance organizer is effective on the macro level of processing while reading.

Herron, York, Cole, and Linden (1998) study compared the effect of declarative versus interrogative advance organizers in facilitating learners' comprehension of a foreign language video. The results indicated that the students' listening comprehension of the foreign language video was greatly improved when advance organizers were used prior to the viewing of the video than not, although there were no significant differences in tests between the two advance organizer experimental groups. Using fifth graders as subjects, Hanley, Herron, and Cole (1995) compared two visual advance organizers and pictures, plus the teacher's narrative, in the comprehension and retention of a written French passage. The result suggested that the video advance organizer was superior in enhancing the comprehension of the foreign text. Herron (1994) conducted an experiment to investigate the effectiveness of using a verbal advance organizer that outlined major scenes from the video. The advance organizer written on the blackboard was presented orally by the teacher, outlining major scenes from the video which both the

control and the advance organizer groups watched in its entirety. The results suggested that an advance organizer was "…a more natural strategy than, for example providing students with a list of fifteen key vocabulary words extracted from the video" (p. 196).

Instructional Visualizations

Recent advances in instructional technology have made it possible to design instructional material that incorporates varied visualizations. Diagrams and images, typically presented as still or static in both print and computer-based environments, can now be animated or programmed to be dynamic to vividly present abstract concepts or phenomena that are invisible to human eyes (Hegarty, 2004; Rieber, 1996). However, visualization has a long history in instructional material and previous research has shown that simply adopting a new technology does not necessarily improve learning (Hegarty, 2004). Generally speaking, animated (dynamic) visualization is more likely than static visuals to present effectively motions or movements imperceptible to the human eye or changes in shapes or motions of objects (Caraballo, 1985; Rieber, 1996; Wong, 1994).

Despite the overwhelming excitement for animated visualization, research studies have not been able to conclude that it is any more effective than static visualization. Szabo and Poohkay (1996) reviewed 20 studies that investigated animation in the CBI environment and found that half of the studies show a significant effect in favor of animation (Alesandrini & Rigney, 1981; Kaiser, Proffitt, & Anderson, 1985; Rieber, 1989; Rieber, Boyce & Assad, 1990) while the other half showed no significant differences (Caraballo, 1985; King, 1975; Moore, Nawrocki, & Simutis, 1979; Reed, 1985; Rieber & Hannafin, 1988). Visuals, such as pictures/static images or video, have gained popularity in foreign/second language teaching for purposes of teaching reading comprehension. Rieber (1996), after conducting a review of static versus animated visualization studies, indicates that animation has been used "…with the intent to impress rather than to teach…." (p. 77). He strongly suggests animation be used only when its attributes are congruent to the learning task. He also cautioned that complex animation may be confusing for novice learners without prior knowledge in the content area, i.e., they may not know how to attend to critical information delivered by the animation (Rieber, 1996; Reed, 1985).

Omaggio (1979) investigated the effect of various types of visuals as context in the reading comprehension of a French text. The results suggested that providing visual contexts effectively enhanced the recall of factual knowledge. Students also demonstrated better performance in reading comprehension than their counterparts who received only the text. To place foreign-text reading in a comprehensible context, ESL/EFL teachers also utilized supplemental material such as news programs, TV programs, or videotapes. Di Carlo (1994) suggested that visuals and specifically, videotexts such as TV commercials, movies, and dramas can enhance language acquisition by providing students various discourse contexts and reducing the anxiety typically experienced in second/foreign language learning.

A relatively large body of similar research has also been conducted with native speakers on different types of learning in a multimedia learning environment. Since the present study draws heavily on Mayer's generative theory of multimedia learning, a brief review of similar research conducted by Mayer and his colleagues is provided here. Mayer, Hegarty, Mayer and Campbell (2005) investigated the effect of annotated illustrations versus narrated animation in multimedia instruction on students' retention and transfer test performance. Students either received a static diagram with explanatory text or animation with narration explaining the process of how lightning, a toilet tank, ocean waves and a car's braking system work. The results indicated that students receiving static diagrams with text scored significantly higher than those receiving animation with narration on four of the eight tests. The study supported the idea that static illustration effectively reduce extraneous cognitive load possibly induced by animation and narration, and on the other hand promotes germane processing.

In another study by Mautone and Mayer (2001), students received a short science lesson on how airplanes lift. Four lessons were prepared for the research. One lesson employed signals including a preview

summary, section headings, and pointer words. The other three lessons included explanations presented as printed text, spoken text, and spoken text with corresponding animation, respectively. Results suggested that students receiving the lesson with signals performed significantly better in the problem-solving task than those who did not. Research on animation has looked into the effect of animated instruction with various types of strategies. Mayer and Moreno (1998) investigated the relative effectiveness of concurrent narration versus on-screen text when they were used to accompany computer-generated animation. Results indicated that learners identified factual knowledge better when explanations were presented via concurrent narration than by on-screen text. Learners also generated more solutions to problems when animated instruction was accompanied with spoken narration than with on-screen text. To sum up, previous studies on visualization have documented the related effectiveness of various types of visualizations and strategies used to accompanying them either with native or non-native speakers of English in different types of learning material and outcomes. However, the authors believe that few studies have compared the learning effects of static and animated visuals, as well as strategies embedded to foster learning from animation in a foreign language context. The only study that we can identify was Xiao and Jones' (1995) study. When investigating potential ways to integrate animation in Computer-Based Instruction (CBI) programs into a language learning environment, Xiao and Jones have suggested that animation be used to teach phonetics, action verbs, and cultural elements.

STATEMENT OF THE PROBLEM

Built on cognitive psychology theories underpinning the use of multimedia to facilitate L2 learners' reading comprehension, this study first examined the effect of cognitive strategies on language learners' comprehension of authentic reading material. The strategies included a combination of advance organizers (questions versus descriptive statements) and visualizations (static versus dynamic). Since learners' reading comprehension level might also affect the strategies that they will employ in the reading process, this study also investigated the relationship of the reading proficiency level and the proposed cognitive strategies on L2 learners' reading comprehension.

Specifically this study addressed the following research questions:

1) What are the relative effects of different cognitive strategies combining advance organizers and visualizations on ESL/EFL learners' reading comprehension of a multimedia-based authentic text?
2) Can cognitive strategies, visuals embedded with advance organizers in a multimedia-based authentic text, compensate for low reading ability?

METHODOLOGY

The Participants

The participants of the study were 115 sophomores (20 males and 95 females) drawn from two sections of an intermediate EFL reading course at a private technical/vocational university in Taiwan. The students were English majors for practical purposes with an age range of 19-24 ($\overline{M}$ =20.0; SD=1.25). At the time of the study, students had been learning English for approximately seven years since English is a required course from the seventh grade up in Taiwan. Participants in this study have not had the experience of studying or living in any English-speaking countries.

Computer-Based Instructional Material

The material used in the current study is a paper-based reading material developed by Dwyer and Lamberski (1977) that describes the parts of the human heart, the circulation of blood flow, and blood pressure. This text contains both general physiology knowledge that English native speakers typically learn in their high school as well as more complex concepts likely learnt in a college freshman biology class. The lesson consisted of 1,821 words split into 20 pages covering a range of learning tasks in

increasing complexity. Each page is accompanied by a contextual visual of a simple line drawing. The material was further developed into a computer-based instructional format with static or animated visuals and advance organizers.

To be consistent across all treatments, all instructional web pages were split into five sections with the title of each page on top and an image of the heart on the right to illustrate the corresponding text in the middle. Supplementary review links were placed on the left-hand side of the screen. At the bottom was a navigation bar that allowed students to go back or move forward.

Treatments

Four computer-based modules were developed respectively for the study. All modules contained identical instructional content. The description of each treatment material is described in the following.

1. Static Visuals Alone (SV)

Students in this group received the instructional material described above accompanied by 20 contextual static visuals. The visuals contained simple line drawings of the part of the human heart. See Figure 1 for a sample screenshot of this treatment.

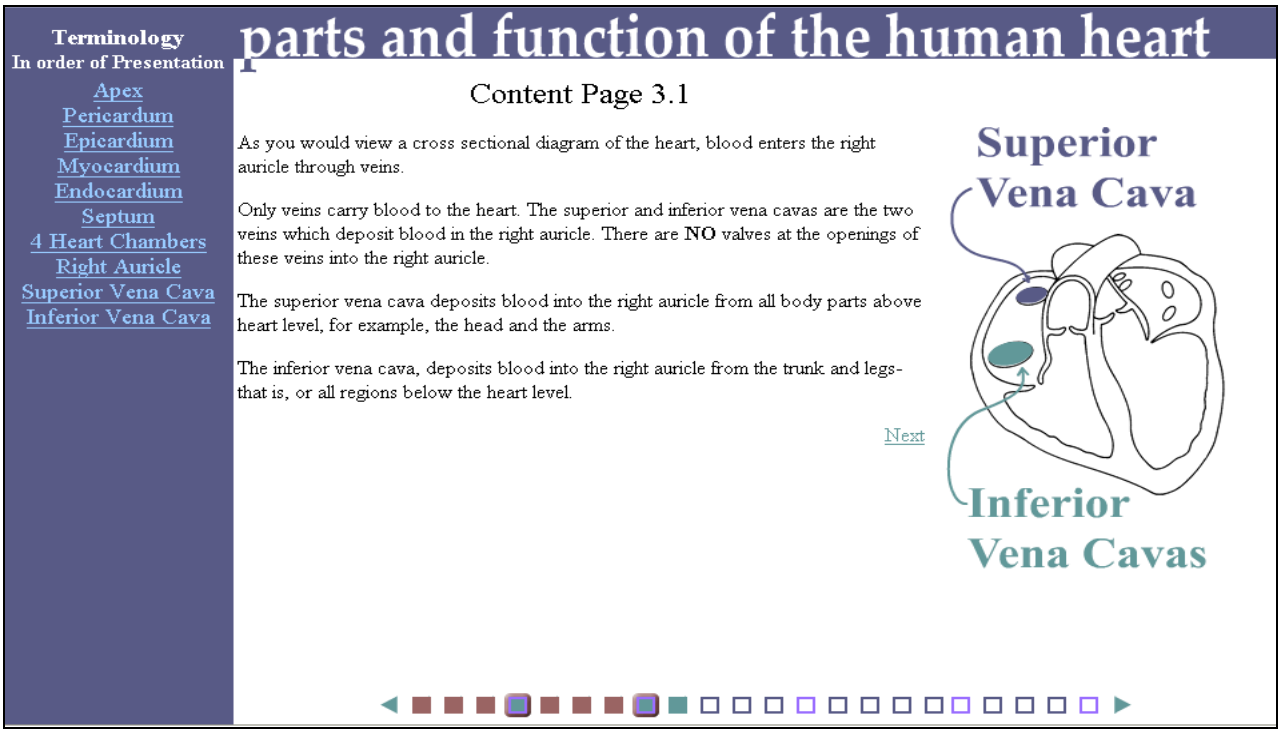


Figure 1. Screen shot of a page containing a static visual

2. Animated Visuals Alone (AN)

Students in this group received an instructional module that contained animated visuals on selected web pages according to a pilot study, which was conducted to determine the parts of the instruction material with which students had difficulties and where animation could be positioned to resolve these difficulties. Students in this group were asked to look at the heart image at the right and read the pertaining text in the middle. Students were encouraged to interact with the animated visuals and associate them with the text. The animation used in the study is of three major types: zoom in/out, motions, and focusing. The purpose of the animated visuals is to illustrate concepts and rules/procedures related to the instructional material that are hard to demonstrate using such static visuals. Students were allowed to review the animated

visuals as many times as they wanted by clicking on the animation button. A sample screenshot of the animated instruction is presented in Figure 2.

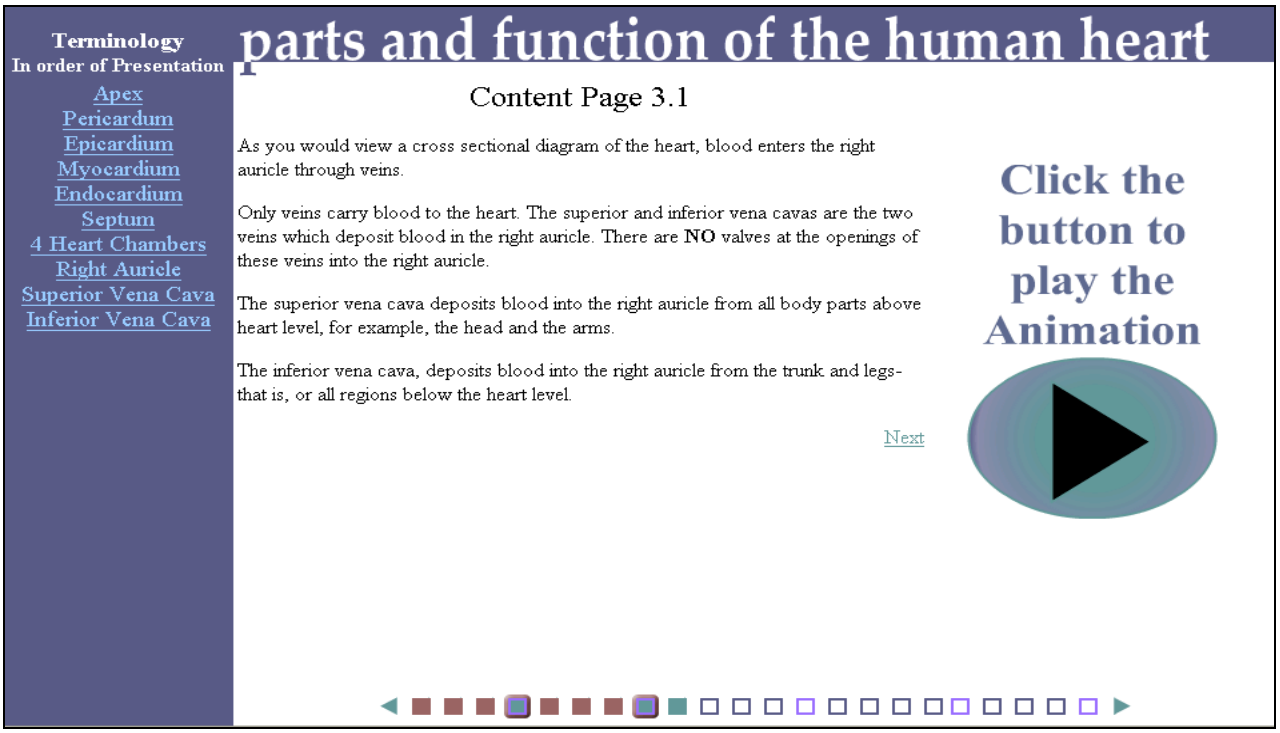


Figure 2. Screen shot of a page containing an animated visual

3. Animated Visuals + Descriptive Advance Organizer (A+D)

Participants in this group received treatment that contained animated instructional material that was exactly the same as those received by the Animation group (AN). However, descriptive advance organizers were placed prior to each frame. Each descriptive advance organizer consisted of a short statement and a supplemental static visual. The purpose of the embedded descriptive advance organizer was to cue learners to crucial concepts that they needed to pay particular attention to in the to-be-encountered material. For a sample screenshot of a frame that contains a descriptive advance organizer, see Figure 3.

4. Animated Visuals+ Question Advance Organizer (A+Q)

Participants in this treatment received the same animated instructional material as the (AN) group. However, students in this group received advance organizers in the form of questions prior to each frame. The question advance organizer consisted of a question and a static visual, which was exactly the same as that received by the (A+D) group. This type of advance organizer asked a question concerning the main concepts in the upcoming material, followed by possible answer choices. Feedback as to the right answer of the question was provided in a pop-up window eight seconds after the appearance of the question. The purpose of the question advance organizer was to activate students' prior knowledge and to encourage elaborate processing of the upcoming material. For a sample screenshot of the frame that contained a question advance organizer, see Figure 4.

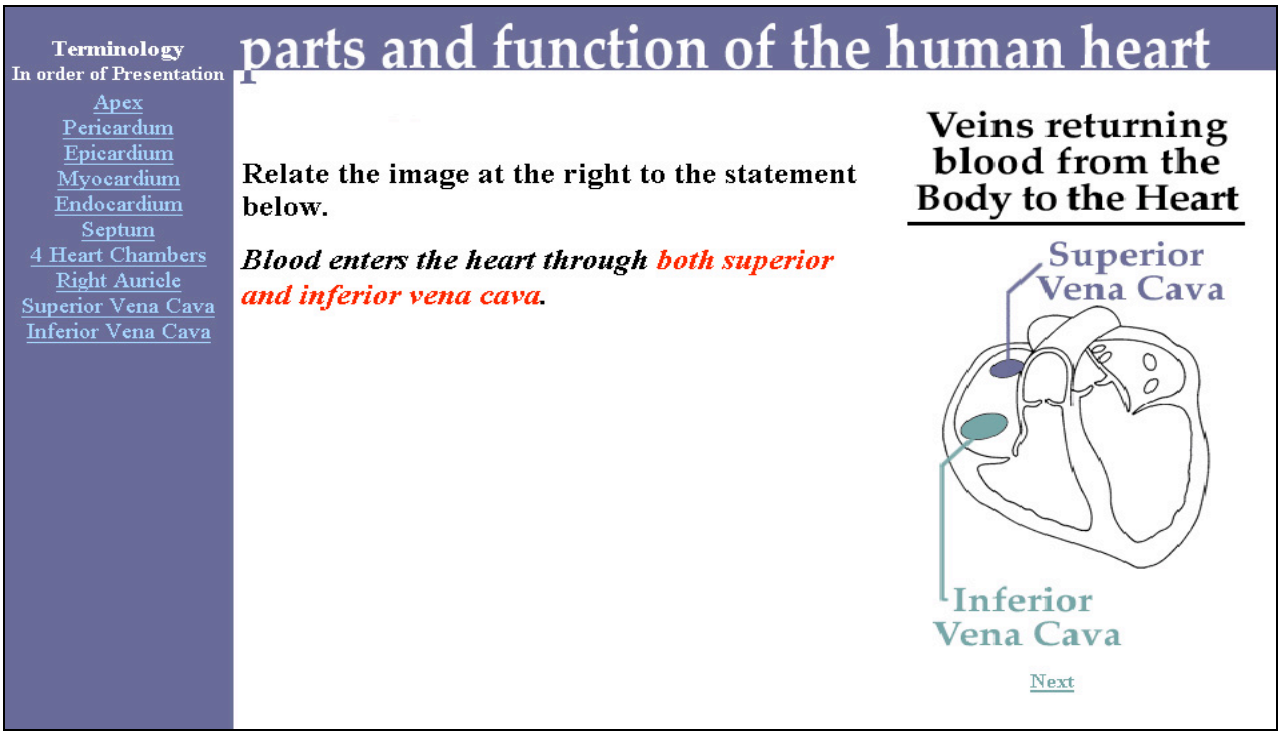


Figure 3. Screen shot of a page containing a descriptive advance organizer

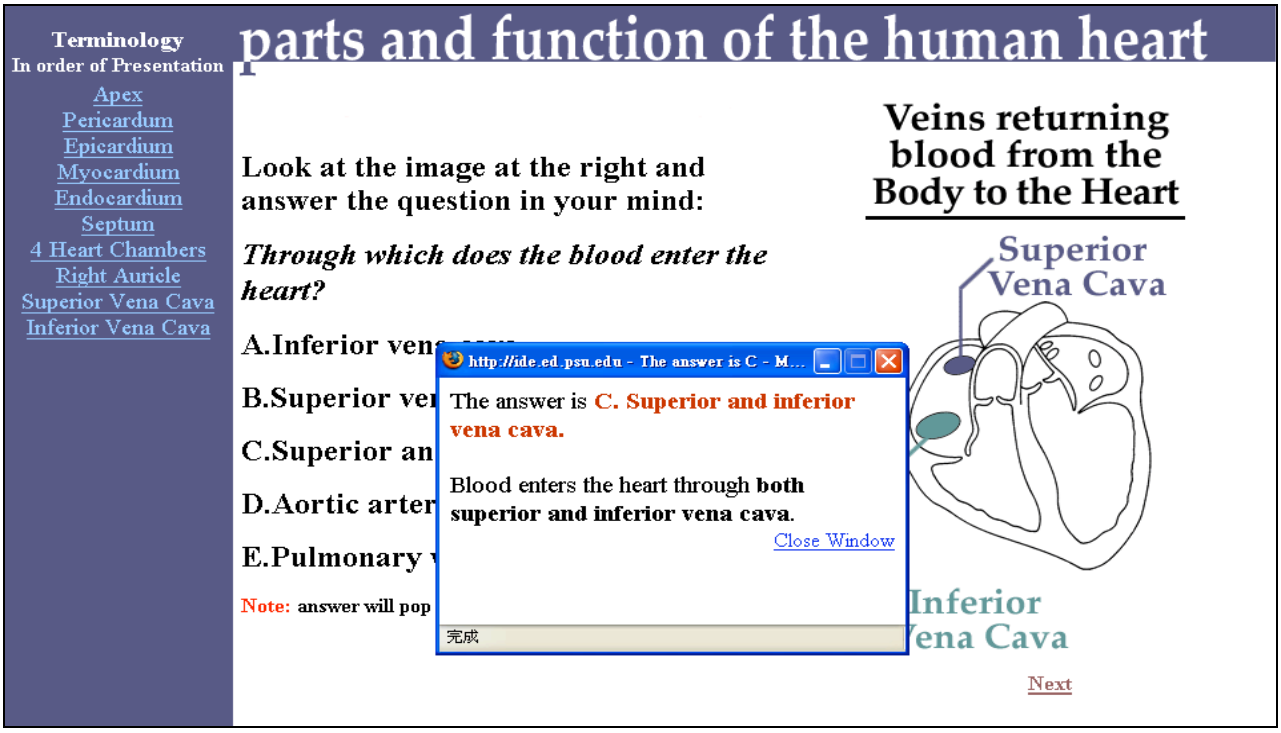


Figure 4. Screen shot of a page containing a question advance organizer

Criterion Measures

Four criterion measures were used to assess students' understanding and retention of the content-based lesson. These four criterion tests measured different levels of reading comprehension of the instructional material, i.e., simple factual/declarative knowledge, concepts, rules/procedures, and comprehension. Each criterion test is composed of 20 items with each item worth one point. The maximum score for each test is 20. Except for the drawing test, the terminology, identification, and comprehension tests consisted of 20 multiple choice questions each. As for the drawing test, students were asked to draw a diagram of the human heart on a piece of paper provided. All the tests, except for the drawing test, were converted to an online format so that after students received their respective treatments, they could immediately take the tests. A detailed description of the criterion measures are provided below. Refer to the Appendix for the complete test questions.

Drawing Test: (Cronbach's alpha =0.83)

The purpose of the drawing test was to measure students' overall understanding of the content-based lesson, as well as their ability to reproduce the parts of the heart in their appropriate context. Each student was provided with a blank piece of paper on which 20 parts of the heart were to be drawn and then identified. Students' drawing ability was not an important factor in the scoring since correct positioning of the 20 parts of the heart was the criterion of assessment. The scorers were two doctoral students with a major in instructional systems. The scorers were trained and given instruction on scoring procedures. The inter-rater reliability of the drawing test for this study was 0.90.

Identification Test: (Cronbach's alpha =0.81)

The purpose of the identification test was to assess students' ability to identify parts of the human heart. In this test, a diagram of the human heart with 20 numbered arrows was provided to students, who had to then choose the corresponding letter for a numbered arrow from four possible answer choices.

Terminology Test: (Cronbach's alpha =0.83)

Students were assessed about their knowledge of specific terms of the human heart and their association with various functions of the human heart. For example, students were assessed whether or not they knew that "superior and inferior vena cavas" is the term for the parts of the human heart through which blood from the body enters the heart.

Comprehension Test: (Cronbach's alpha =0.77)

This test consisted of more difficult comprehension questions that required students' understanding of facts, rules/procedures, and simple concepts pertaining to this content-based lesson. Specifically, the test covered questions that asked about the function of the human heart in both the diastolic and systolic phases. In particular, given a description of how a part of the human heart was functioning, students needed to be able to understand a simultaneous functioning of another part(s) of the human heart. Position or status of relative parts while specific parts of the human heart are operating needed to be fully comprehended by the students for them to score high on the test.

Total Score: (Cronbach's alpha =0.92)

Scores from above four tests were added up and a grand total was attained; the total score was used to examine students' overall understanding of the instructional material.

Procedure

The procedures were divided into two stages. In the first stage, the instructor provided students with readings in which the content was relevant to the material used in the study. The readings were simplified in terms of the level of difficulty in vocabulary and content. The purpose was to provide students with

general background knowledge related to the human heart before they were exposed to the experimental material originally developed for English native speakers at the college level. The use of material at a reduced difficulty prior to the experiment was also intended to decrease the level of frustration for students because, generally speaking, students in this EFL context do not possess advanced physiology knowledge unless they are majors in this discipline. A glossary listing important professional words with their Chinese translation was provided to students, and they were encouraged to remember the list to facilitate the understanding of the pre-experimental material.

The second stage of the experiment was conducted in a multimedia language lab during normally scheduled class hours. Prior to receiving respective treatment, students were tested on their English reading comprehension via taking a sub-test on TOEFL in their intact reading class. Upon completion of the reading test, students were seated in a multimedia language lab in which each treatment was installed and the introduction page was displayed. Students, randomly assigned to each treatment, then received the respective treatment material and completed the four criterion measures. Students took the same criterion measures again four weeks later after the experiment. During the four-week period, students had no access to the treatment material or the answers to the tests nor were they informed beforehand that the same tests would be given the second time four weeks later.

RESULTS

Reading Comprehension Test

The reading comprehension test was a subtest of an institutional TOEFL and consisted of 37 multiple choice questions assessing students' understanding of five reading passages in different lengths. The maximum score for the reading test is 37. Table 1 summarizes the means and standard deviations of the reading comprehension test scores achieved by the four treatment groups.

Table 1. Means and Standard Deviations of Reading Comprehension Test Score

	(SV)	**(AN)**	**(A+D)**	**(A+Q)**
Mean	20.10	19.07	20.31	20.00
SD	1.34	1.22	1.87	1.67
Minimum	11	11	14	10
Maximum	29	30	28	37

Participants were further divided into low and high Reading Proficiency Levels (RPL) based on the mean reading score of the sample ($\overline{M}$ =19.87, SD=1.39). As a result, 65 students were classified into low RPL and 50 students into high RPL. The distribution of participants in each treatment in terms of reading proficiency level is summarized in Table 2.

Table 2. Number (*n*) of Subjects Based on RPL for Each Treatment Group

Level	**(SV)**	**(AN)**	**(A+D)**	**(A+Q)**	**TOTAL**
LOW	13	18	16	18	65
HIGH	16	11	13	10	50
TOTAL	29	29	29	28	115

Main Effect of Treatments

A two-way analysis of variance (ANOVA) was conducted on the four immediate criterion tests. The results suggested that there was no interaction between the treatment group and the level of reading comprehension on each of the criterion tests. However, the main effects of the treatments were observed in each of the criterion tests. Table 3 summarizes the means and standard deviations of each immediate criterion test among the groups for the main effect of treatments on these groups. As indicated, the (A+Q)

group outperformed the other three groups in all of the tests. The (SV) group scored the lowest in all except the terminology tests. For treatments in which the advance organizers were embedded, the question advance organizer seemed to be more effective than the descriptive advance organizer in facilitating the students' performance on the tests.

Table 3. Main Effects of Treatment on Each Immediate Criterion Test

Tests	**(SV)*(n=29)***	**(AN)*(n=29)***	**(A+D)*(n=29)***	**(A+Q)*(n=28)***	***F* value**
Drawing	14.67 (1.80)	16.03 (.44)	17.09 (.62)	18.15 (1.69)	6.501***
Identification	17.16 (1.15)	18.63 (.32)	18.34 (.03)	19.13 (.82)	4.592**
Terminology	10.31 (.79)	10.98 (.12)	10.14 (.95)	13.02 (1.92)	3.481*
Comprehension	8.00 (1.37)	8.98 (.40)	9.57 (.19)	11.00 (1.63)	4.612**
Total	50.14 (5.11)	54.61 (.64)	55.14 (.11)	61.31 (6.06)	6.686***

Note: Value in parenthesis indicated standard deviation. * $p<.05$. ** $p<.01$. *** $p<.001$.

Tukey post-hoc tests were used to investigate the differences found in a significant main effect for treatment. The significance level and the mean difference of treatment groups are shown in Table 4.

Table 4. Tukey HSD Post-hoc Tests of Treatment Effect on Each Immediate Test

Tests	**Pair-wise Comparisons**		**Mean Difference**	***P* value**
	(A)	**(B)**	**(B-A)**	
Drawing	(SV)	(A+D)	2.31	.028*
		(A+Q)	3.28	.001**
Identification	(SV)	(A+Q)	1.83	.006**
Terminology	(A+D)	(A+Q)	2.68	.039*
Comprehension	(SV)	(A+Q)	2.72	.007*
Total	(SV)	(A+Q)	10.13	.001**
	(AN)	(A+Q)	6.58	.045*

* $p<.05$. ** $p<.01$. *** $p<.001$.

Another two-way analysis of variance was conducted on the four delayed criterion posttests. Again, no interaction between the treatment group and RPL was observed on all of the criterion posttests. However, the main effects of the treatments were observed in three of the criterion tests and the total score as shown in Table 5.

Table 5. Main Effects of Treatment on Each Delayed Criterion Posttest

Tests	**(SV) *(n=29)***	**(AN)*(n=29)***	**(A+D)*(n=29)***	**(A+Q)*(n=28)***	***F* value**
Drawing	7.20 (3.17)	8.65 (1.72)	12.18 (1.80)	13.57 (3.20)	12.039***
Identification	11.75 (2.43)	13.91 (.27)	14.14 (.04)	17.02 (2.84)	8.36***
Terminology	7.30 (.90)	8.04 (.16)	7.87 (.32)	9.61 (1.42)	2.331
Comprehension	6.41 (1.17)	7.76 (.17)	7.51 (.07)	8.69 (1.11)	2.882*
Total	32.68 (7.75)	38.76 (1.67)	41.71 (1.27)	48.88 (8.44)	8.565***

Note: Value in parenthesis indicated standard deviation. * $p<.05$. ** $p<.01$. *** $p<.001$.

Tukey post hoc tests were used to investigate the differences found in a significant main effect for treatment and the results were shown in Table 6.

Table 6. Tukey HSD Post-hoc Tests of Treatment Effect on Each Delayed Posttest

Tests	Pair-wise Comparisons (A)	(B)	Mean Difference (B-A)	*P* value
Drawing	(SV)	(A+D)	4.79	.001**
		(A+Q)	6.01	.000***
	(AN)	(A+D)	3.66	.015*
		(A+Q)	4.88	.001**
Identification	(SV)	(A+Q)	4.86	.000**
	(AN)	(A+Q)	3.06	.022*
Comprehension	(SV)	(A+Q)	2.16	.030*
Total	(SV)	(A+D)	8.38	.049*
		(A+Q)	14.98	.000***
	(AN)	(A+Q)	9.98	.013*

$p<.05$. $^{**}p<.01$. *** $p<.001$.

Table 7 provides a summary of the main effects of treatment on both immediate and delayed posttests. As indicated, the (A+Q) group performed significantly better than the (SV) group in three of the tests and the total score but not in the terminology test, both for the immediate and delayed tests. One major interest of the study was to determine the relative effectiveness of question and descriptive advance organizers. Table 7 shows that the (A+Q) group only significantly outperformed (A+D) in the immediate terminology test. Regarding the effect of animation compared to static visuals alone, to our disappointment, (AN) did not perform significantly better in any of the tests than the (SV) group, consistently for immediate and delayed tests. However, the provision of advance organizers of either type to accompany animation did have a marginal effect compared to not having provided it at all, as students in (A+D) and (A+Q) groups both scored higher in delayed drawing test than students in the (AN) group. Students in the (A+Q) group also scored higher in the delayed identification test than the (AN) group. Descriptive types of advance organizers only showed a marginal effect compared to static visuals alone as the (A+D) group outperformed the (SV) group only on the immediate and delayed drawing tests and scored higher in total score in the delayed test.

Table 7. Summary of Treatment Effect on Immediate/Delayed Criterion Posttests

Criterion tests	Immediate	Delayed
Drawing	(AQ)>(SV), (AD)>(SV)	(AQ)>(SV),(AD)>(SV),(AD)>(AN),(AQ)>(AN)
Identification	(AQ)>(SV)	(AQ)>(SV),(AQ)>(AN)
Terminology	(AQ)>(AD)	
Comprehension	(AQ)>(SV)	(AQ)>(SV)
Total	(AQ)>(SV),(AQ)>(AN)	(AQ)>(SV), (AD)>(SV),(AQ)>(AN)

Main effects of RPL

The main effects of the reading proficiency level were observed in two of the immediate criterion tests, i.e., terminology and comprehension tests, and the total test score. As indicated in Table 8, high RPL students significantly outperformed low RPL students in terminology and comprehension tests. High RPL students also have a significantly higher total score.

The main effect of RPL was observed in three of the delayed criterion tests, drawing, identification, and terminology tests, and the total score. As indicated in Table 9, high RPL students outperformed low RPL students at a statistically significant level in all but the comprehension test; in addition, high RPL students also had a significantly higher total score.

Table 8. Main Effects of Reading Proficiency Level on Each Immediate Criterion Test

RPL	Low	High	*F* value	*P* value
Drawing	16.00 (.47)	17.08 (.61)	4.233	.072
Identification	18.00 (.31)	18.70 (.40)	4.121	.075
Terminology	10.18 (.91)	12.28 (1.19)	8.642	.004**
Comprehension	8.75 (.63)	10.19 (.82)	5.996	.016*
Total	52.93 (2.31)	58.25 (3.01)	8.868	.004**

Note: Value in parenthesis indicates standard deviation; *p<.05; ** p<.01

Table 9. Main Effect of Reading Proficiency Level on Each Delayed Criterion Test

RPL	Low	High	*F* value	*P* value
Drawing	9.58 (.79)	11.40 (1.30)	4.411	.038*
Identification	13.26 (.92)	15.38 (1.20)	7.918	.006**
Terminology	7.37 (.82)	9.26 (1.07)	8.406	.005**
Comprehension	7.33 (.25)	7.91 (.33)	1.116	.293
Total	37.72 (2.72)	43.97 (3.53)	7.285	.008**

Note: Value in parenthesis indicates standard deviation;* p<.05; ** p<.01

DISCUSSION

The main purpose of the present study was to examine the effectiveness of different cognitive strategies employing a combination of visuals and advance organizers in facilitating EFL/ESL learners' reading comprehension of authentic material. The underlying theoretical assumption was that comprehension may be facilitated by inclusion of varied types of visuals that assist in the selection, organization, and integration of information, and that advance organizers provide a cognitive structure that enables existing schemas to be connected and integrated with new ones. The present study also examined the role that learners' reading proficiency may play in learning from authentic material presented in a multimedia learning environment and its interactive effect with the proposed cognitive strategies on students' learning. A discussion of findings pertaining to each research question is described in the following.

Research Question 1. What are the relative effects of different cognitive strategies combing advance organizers and visualizations on ESL/EFL learners' reading comprehension of a multimedia-based authentic text?

The results of this study regarding the treatment effect can be summarized as (1) *Animation embedded with a question advance organizer (A+Q) is more effective than static visuals alone (SV).* Students assigned to (A+Q) performed better on all immediate and delayed criterion subtests as well as a higher total score than those assigned to the (SV) group except the immediate terminology test for which (SV) is superior to (A+D). *(2) Animated visuals were found to be equally effective as static visuals.* This study did not support the use of animation in facilitating reading comprehension of authentic material. Students receiving (AN) treatment did not perform significantly better in any of the criterion posttests than those who received (SV) treatment, indicating that animation alone did not have an effect in assisting with the understanding of the material as expected. This finding was valuable. While advances in technology have made dynamic presentations of visuals easy and possible, the cost associated with the development of animation must be evaluated against its effectiveness. *(3) A question advance organizer is only marginally more effective than a descriptive advance organizer.* Students assigned to (A+Q) outperformed those in (A+D) only in immediate terminology test, indicating the qualitative features of learning that these two types of advance organizer can induce may be of little difference and therefore failed in resulting in significant improvement of comprehension. *(4) Provision of advance organizers of either type to accompany animation did have a marginal effect compared to not providing them at all.* The results indicated that students in (A+D) and (A+Q) groups both scored higher on the delayed drawing

test than students in the (AN) group. Students in (A+Q) group also scored higher on the delayed the identification test than the (AN) group.

In sum, this study found no superior effect of animation in assisting with the comprehension of authentic reading material. Static visuals/pictures are equally effective in assisting learners' comprehension of the material. Nevertheless, the most important finding of this study was that, with the addition of a question advance organizer, animation was a more effective cognitive strategy to enhance reading comprehension of authentic material. The finding suggests that animation alone is no better than static pictures; however, when complementing the animation with a question advance organizer, or in the case of the delayed drawing test a descriptive advance organizer, its effect was noticeable. Students receiving animation plus question advance organizer significantly outperformed the static visual alone (SV) group in all of the immediate criterion posttests (except terminology test) and all three delayed criterion posttests. It was plausible that the question advance organizer embedded in the animation assisted students in focusing on critical information represented by the animation. Previous researchers indicated that learners, when presented with the animated instruction, were not able to "…effectively attend to the animation" or were "…distracted by the combination of visual and verbal information presented to them" (Rieber, 1990, p. 81). Owens & Dwyer (2005) also found that learners failed to focus on critical aspects of the animation that depicted important concepts. They were not able to effectively interact with the animation and fully benefit from it. Wilson and Dwyer (2001) suggested in their study that learners be given sufficient and appropriate prompts that help them focus on essential and critical aspects of the information.

The present study echoes previous studies in that certain pedagogical strategies needed to be used to complement animation for students to benefit from its robust representation. Different types of questions or questioning strategies can be used to engage learners in deeper cognitive information processing and therefore enhance their learning. The effects of questions or questioning strategies lie in the fact that the "… explicitness of the questions and … relationship to instruction…focus [the] learner process on question-specific information" (Osman & Hannafin, 1994, p. 5).

Research Question 2. Can cognitive strategies, i.e. visuals with advance organizers embedded in a multimedia-based authentic text compensate for low reading ability?

One purpose of this study was to investigate the relationship between ESL/EFL learners' reading comprehension level and different cognitive strategies used to enhance their reading comprehension of authentic material. Specifically, the researchers wished to explore whether the employment of the cognitive strategies would close the gap in comprehension between the two groups. The researchers hypothesized that the students' reading comprehension level would have an effect on how they make use of the cognitive strategies and consequently affect reading comprehension of the authentic material. The results did not support the above mentioned hypothesis. Students with different levels of reading comprehension did not score differently depending on the cognitive strategies employed in the authentic material. Students with a higher RPL, regardless of what cognitive strategy they received, scored consistently higher in criterion tests than those with a lower RPL, except on the drawing and identification immediate posttests and on the delayed comprehension posttest. As mentioned earlier, the finding that higher RPL students scored higher in the more difficult and complex immediate criterion posttest than their lower RPL counterparts is not surprising. However, it is interesting that lower RPL students performed equally well as those with a higher RPL on a lower level of immediate reading comprehension questions. However, the study also found that there were no significant differences on the delayed comprehension posttest between the two groups. Kloster & Winne (1989) in their study investigating the effects of different types of organizers on students' learning from text indicated that advance organizers "….influence qualitative features of learning…" (p. 9). Studies also showed that advance organizers are more effective in facilitating retention of conceptual knowledge rather than factual details and may actually impede the recall of specific details (Mayer, 1980; Mayer & Bromage, 1980).

Inconsistent findings also existed regarding the effect of advance organizers for lower and higher ability learners. Mayer's studies (1979, 1980) found positive effects of advance organizers for inexperienced learners while Derry (1984) found that high-ability learners benefit from advance organizers. Kloster & Winne (1989) actually indicated in their study that how students relate the new information in a text to an advance organizer determines the effectiveness of an advance organizer. Students' achievement improves if they were able to link the information in the text to the advance organizers. Their study suggested that previous studies that found no effect of advance organizers might be due to learners' "… ineffective use of the advance organizers rather than to characteristics of the organizers themselves" (p.14). The current research has failed to provide evidence that dynamic visuals and advance organizers can be used to scaffold students with lower RPL in comprehending more complex authentic material although these strategies might be effective on their achievement in the basic reading measures or on a long-term comprehension measure.

CONCLUSION

The major findings of the study can be summarized as follows. First, dynamic visualization used to complement verbal information contained in the authentic material was no more effective than static visuals. Rieber (1996) proposed that animation could be used to provide the illusion of movement (motion) and the path of travel (trajectory). Consequently, the learning tasks or content should depend on the understanding of the changes of an object over time or the direction towards which the object is moving. Greater learning gains would be expected if the learning task involved the understanding of concepts that concern motion and trajectory and if the animated visuals are integrated to enhance learning. The instructional material in this study was selected deliberately to provide justification for the use of animated visuals. However, students assigned to the (AN) group did not significantly outperform those not receiving animation.

Research so far conducted to compare the effects of static and dynamic/animated visualization on students' learning has been mixed and mostly discouraging. In spite of the overwhelming excitement about animated visualization, research studies have not been able to conclude that it is any more effective than static visualization. The present study reinforces previous research findings and provides evidence that static visuals and dynamic visuals as represented via animation are equally effective in facilitating reading comprehension in an ESL/EFL context.

Secondly, for animation to be effective, a question advance organizer may be used to prepare learners' cognitive structure for new and unfamiliar schema. It is generally agreed that learners have in their possession various degrees of meta-cognitive resources that enable them to engage in the lesson content with varying degrees of depth (Osman & Hannafin, 1994). Research has indicated that questions help to activate prior knowledge and integrate it with new knowledge and the application of that knowledge (Adams & Bruce, 1980; Anderson & Biddle, 1975; Anderson & Pearson, 1984; Mayer, 1984; Osman & Hannafin, 1994). This study further reinforces the instructional effect of using questions as an advance organizer in facilitating students' learning.

Third, when the purpose is to complement animation, the question advance organizer is only marginally more effective than the descriptive advance organizer. This finding was based on the evidence that the (A+Q) group only outperformed the (A+D) group in one of the criterion posttests, i.e., the terminology test. It is plausible that the level/depth of information processing induced by both kinds of advance organizers is approximately similar. In this study, the question advance organizer is used as a cue to activate students' existing schema; however, since no overt responses were required of students to the questions, students may be rendered as passive learners as were those who received a descriptive advance organizer. Both types of advance organizers cued learners to important information but were not significantly different with regard to increasing the depth of information that they called upon.

LIMITATIONS OF THE STUDY

There has been very little empirical research on the instructional value of various kinds of visualization with accompanying strategies in enhancing the understanding of subject matter knowledge in an ESL/EFL context. We recommend further research duplicating our treatments with different learning materials, participants, and perhaps in different learning environments. The conclusions we have drawn are limited by the background of the participants, nature of the learning tasks, and assessment tools.

The experimental lessons consisted of a general physiology lesson related to the human heart accompanied by simple static visuals, animations, and animations plus different advance organizers. It is possible that due to the nature of the learning tasks, the amount of time that is required for the students to complete the treatment lessons were not comparable. In other words, as one of the reviewers has enquired, time-on-task might have been an issue in this study. Students assigned to the more interactive lesson, i.e. animation plus question advance organizer had more exposure to the materials as compared to the less interactive lesson, i.e. static visuals only condition. Therefore, the authors were cautious in making the conclusion that the obtained results were due to the advance organizers and visualizations used but not due to the differences in the amount of time spent by students in learning the lesson. It was arguable that the time-on-task might have been a confounding variable that would interrelate with the major treatment effect to affect learning achievement. However, some media require more time to deliver/present instructional material by their nature. Smyth (1985) pointed out that student-engaged learning time was a "necessary" but not sufficient mediating process in classroom research on learning. He argued that while allocated time was useful in interpreting learning results, it was the amount of time during which a student was *actively engaged* with the subject matter that was most crucial and that directly contributed to learning. Rothkopf (1970) also emphasized that "… in most instructional situations, what is learned depends largely on the activities of the student…." (p. 325). Anderson (1970) also noted that "… the activities that the student engages in when confronted with instructional tasks are of crucial importance in determining what he will learn…." (p. 349).

Whether the additional amount of time needed to learn the designated material would warrant additional learning gains is open to question, not to mention the cost required to develop enriched learning materials such as the animated visuals used in this study. The authors suggest that more research is needed to explore the relationship between effectiveness and efficiency in a technology-enhanced learning environment.

APPENDIX

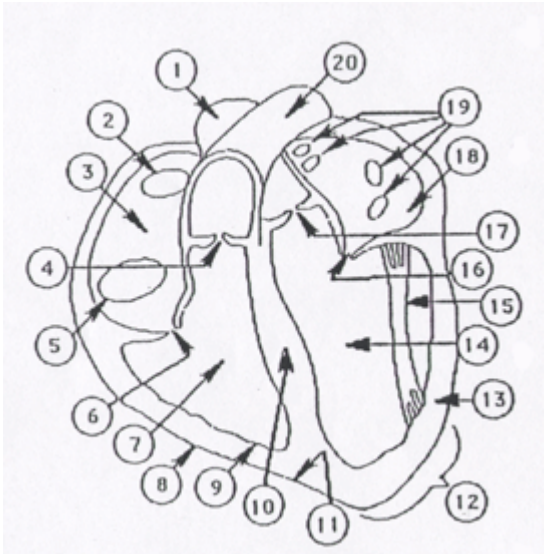
DRAWING TEST

Directions: Draw a simple line picture of a heart and place the corresponding number of the 20 identified parts, where they would be located on the heart.

1. Superior Vena Cava
2. Aorta
3. Tricuspid Valve
4. Pulmonary Veins
5. Septum
6. Epicardium
7. Aortic Valve
8. Pulmonary valve
9. Inferior Vena Cava
10. Pulmonary Artery
11. Myocardium
12. Endocardium
13. Mitral Valve
14. Right auricle
15. Right ventricle
16. Left auricle
17. Left ventricle
18. Apex
19. Tendons
20. Pericardium

IDENTIFICATION TEST

Directions: **Circle the answer on the answer sheet** you feel best identifies the part of the heart indicated by the numbered arrows.



21. Arrow number one (1) points to the
A.Septum
B. Aorta
C. Pulmonary Artery
D. Pulmonary Vein
E. None of These

22. Arrow number two (2) points to the
A.Superior Vena Cava
B.Inferior Vena Cava
C.Pulmonary Artery
D.Tricuspid Valve
E.Aorta

23. Arrow number three (3) points to the
A.Right Ventricle
B.Right Auricle
C.Left Ventricle
D.Left Auricle
E.Heart Muscle

24. Arrow number four (4) points to the
A.Pulmonary Valve
B.Pulmonary Vein
C.Aortic Valve
D.Tricuspid Valve
E.Mitral Valve

25. Arrow number five (5) points to the
A.Aorta
B.Pulmonary Artery
C.Superior Vena Cava
D.Inferior Vena Cava
E.Pulmonary Vein

26. Arrow number six (6) points to the
A.Aortic Valve
B.Pulmonary Valve
C.Mitral Valve
D.Tricuspid Valve
E.Semi-Lunar Valve

27. Arrow number seven (7) points to the
A.Left Ventricle
B.Right Ventricle
C.Right Auricle
D.Left Auricle
E.Vascular Space

28. Arrow number eight (8) points to the
A.Myocardium
B.Ectoderm
C.Pericardium
D.Endocardium
E.Epicardium

29. Arrow number nine (9) points to the
A.Endocardium
B.Myocardium
C.Pericardium
D.Ectoderm
E.Septum

30. Arrow number ten (10) points to the
A.Endocardium
B.Pericardium
C.Septum
D.Myocardium
E.Aortic Base

31. Arrow number eleven (11) points to the
A.Epicardium
B.Pericardium
C.Endocardium
D.Myocardium
E.None of These

32. Arrow number twelve (12) points to the
A.Pericardium
B.Myocardium
C.Endocardium
D.Endoderm
E.Apex

33. Arrow number thirteen (13) points to the
A.Pericardium
B.Endocardium
C.Ectocardium
D.Endoderm
E.Myocardium

34. Arrow number fourteen (14) points to the
A.Right Ventricle
B.Left Ventricle
C.Left Auricle
D.Right Auricle
E.Apex

35. Arrow number fifteen (15) points to the
A.Pulmonary Veins
B.Tendons
C.Aortas
D.Pericardium
E.None of These

36. Arrow number sixteen (16) points to the
A.Venic Valve
B.Pulmonary Valve
C.Tricuspid Valve
D.Mitral Valve
E.Aortic Valve

37. Arrow number seventeen (17) points to the
A.Superior Vena Cava
B.Tricuspid Valve
C.Aortic Valve
D.Pulmonary Valve
E.Mitral Valve

38. Arrow number eighteen (18) points to the
A.Right Auricle
B.Right Ventricle
C.Left Auricle
D.Left Ventricle
E.Semi-lunar Chamber

39. Arrow number nineteen (19) points to the
A.Inferior Vena Cava
B.Superior Vena Cava
C.Aortas
D.Pulmonary Veins
E. Pulmonary Arteries

40. Arrow number twenty (20) points to the
A.Inferior Vena Cava
B.Aorta
C.Pulmonary Artery
D.Septum
E.Superior Vena Cava

TERMINOLOGY TEST

Directions: **Circle the answer on the answer sheet** you feel best completes the sentence.

41. _____ is(are) the thickest walled chamber(s) of the heart.
A.Auricles
B.Myocardium
C.Ventricles
D.Pericardium
E.Endocardium

42. The contraction of the heart occurs during the _____ phase.
A.Systolic
B.Sympathetic
C.Diastolic
D.Parasympathetic
E.Sympatric

43. Lowest blood pressure in the arteries occurs during the _____ phase.
A.Sympatric
B.Sympathetic
C.Diastolic
D.Systolic
E.Parasympathetic

44. Blood from the right ventricle goes to the lungs through the _____.
A.Tricuspid Valve
B.Aortic Artery
C.Pulmonary Artery
D.Pulmonary Veins
E.Superior Vena Cava

45. The _____ is(are) the strongest section(s) of the heart.
A.Left Ventricle
B.Aorta
C.Septum
D.Right Ventricle
E.Tendons

46. When blood returns to the heart from the lungs, it enters the _____.
A.Left Auricle
B.Pulmonary Valve
C.Left Ventricle
D.Right Ventricle
E.Pulmonary Artery

47. Vessels that allow the blood to flow from the heart are called the _____.
A.Veins
B.Arteries
C.Apex
D.Tendons
E.Valves

48. Blood passes from the left ventricle out the aortic valve to the _____.
A.Lungs
B.Body
C.Aorta
D.Pulmonary Artery
E.Left Auricle

49. The chamber of the heart which pumps oxygenated blood to all parts of the body is the _____.
A.Right Auricle
B.Left Auricle
C.Aorta
D.Left Ventricle
E.Right Ventricle

50. The _____ is another name for the part of the heart called the heart muscle.
A.Apex
B.Epicardium
C.Endocardium
D.Myocardium
E.Septum

51. _____ is(are) the part(s) of the heart which controls its contraction and relaxation.
A.Myocardium
B.Endocardium
C.Ventricles
D.Auricles
E.Septum

52. The _____ is the name given to the inside lining of the heart wall.
A.Epicardium
B.Endocardium
C.Pericardium
D.Myocardium
E.Septum

53. Blood from the body enters the heart through the _____.
A.Aortic Artery
B.Pulmonary Veins
C.Pulmonary Artery
D.Superior and Inferior Vena Cavas
E.Superior Vena Cava Only,

54. The membrane which borders on the inside lining of the pericardium and is connected to the heart muscle is called the _____.
A.Extoxim
B.Epicardium
C.Endocardium
D.Myocardium
E.Ectocardium

55. The _____ allow(s) blood to travel in one direction only.
A.Septum
B.Valves
C.Arteries
D.Veins
E.Tendons

56. The _____ is the common opening between the right auricle and the right ventricle.
A.Mitral Valve

B.Tricuspid Valve
C.Septic Valve
D.Pulmonary Valve
E.Aortic Valve

57. The _____ is the triangular flapped valve between the left auricle and the left ventricle.
A.Aortic Valve
B.Pulmonary Valve
C.Septic Valve
D.Tricuspid Valve
E.Mitral Valve

58. The semi-lunar valves are located at the entrance to the _____.
A.Pulmonary Veins
B.Superior and Inferior Vena cavas
C.Pulmonary and Aortic Arteries
D.Mitral and Tricuspid Valves
E.ventricles

59. The outside covering of the heart is called the _____.
A.Endocardium
B.Epicardium
C.Pericardium
D.Myocardium
E.None of These

60. Immediately before entering the aorta, blood must pass through the _____.
A.Left Ventricle
B.Mitral Valve
C.Lungs
D.Superior Vena Cava
E.Aortic Valve

COMPREHENSION TEST

Directions: Circle the answer on the answer sheet you feel best answers the question.

61. Which valve is most like the tricuspid in function?
A.Pulmonary
B.Aortic
C.Mitral
D.Superior Vena Cava

62. When blood is being forced out the right ventricle, in which position is the tricuspid valve?
A.Beginning to open
B.Beginning to close
C.Open
D.Closed

63. When the blood is being forced out the aorta, it is also being forced out of the.
A.Pulmonary Veins
B.Pulmonary Arteries
C.Superior Vena Cava
D.Cardiac Artery

64. The contraction impulse in the heart starts in
A.The Right Auricle
B.Both ventricles simultaneously
C.Both Auricles Simultaneously
D.The Arteries

65. In the diastolic phase the ventricles are
A.Contracting, full of blood
B.Contracting, partially full of blood
C.Relaxing, full of blood
D.Relaxing, partially full of blood

66. During the first contraction of the systolic phase, in what position will the mitral valve be?
A.Begging to open
B.Open
C.Beginning to close
D.Closed

67. During the second contraction of the systolic phase, blood is being forced away from the heart through the
A.Pulmonary and Aortic Arteries
B.Superior and Inferior Vena Cavas
C.Tricuspid and Mitral Valves
D.Pulmonary Veins

68. When blood is entering through the vena cavas, it is also entering through the
A.Mitral Valve
B.Pulmonary Veins
C.Pulmonary Artery
D.Aorta

69. When the heart contracts, the
A.Auricles & Ventricles contract simultaneously
B.Ventricles contract first, then the auricles
C.Right side contracts first, then the left side
D.Auricles contract first, then the ventricles

70. While blood from the body is entering the superior vena cava, blood from the body is also entering through the
A.Pulmonary Veins
B.Aorta
C.Inferior Vena Cava
D.Pulmonary Artery

71. When the blood leaves the heart through the pulmonary artery, it is also simultaneously leaving the heart through the
A.Tricuspid Valve
B.Pulmonary veins
C.Aorta
D.Pulmonary Valve

72. When the pressure in the right ventricle is superior to that in the pulmonary artery, in what position is the tricuspid valve?
A.Closed
B.Open
C.Beginning to Close
D.Confined by pressure from the right auricle

73. When the ventricles contract, blood is forced out the
A.Superior and Inferior Vena Cavas
B.Pulmonary veins
C.Tricuspid and Mitral Valves
D.Pulmonary and Aortic Valves

74. Blood leaving the heart through the aorta had left the heart previously through the
A.Vena cavas
B.Pulmonary veins
C.Pulmonary artery
D.Tricuspid and Mitral Valves

75. When the blood in the aorta is exerting a superior pressure on the aortic valve, what is the position of the mitral valve?
A.Closed
B.Open
C.Beginning to open
D.Confined by pressure from the right ventricle

76. When the tricuspid and mitral valves are forced shut, in what position is the pulmonary valve?
A.Closed
B.Beginning to open
C.Open
D.Beginning to close

77. During the second contraction of the systolic phase, in what position is the aortic valve?
A.Fully open
B.Partially open
C.Partially closed
D.Fully closed

78. Blood is being forced out the auricles simultaneously as blood is
A.Entering only the vena cavas
B.Being forced out the pulmonary and aortic valves
C.Passing through the tricuspid & mitral valves
D.Being forced out through the pulmonary artery

79. If the aortic valve is completely open, the
A.Second contraction of the systolic phase is occurring
B.Diastolic phase is occurring
C.Tricuspid & mitral valves are completely open
D.Blood is rushing into the right & left ventricles

80. When the heart relaxes, the
A.Auricles relax first, then the ventricles
B.Right side relaxes first, then the left side
C.Left side relaxes first, then the right side
D.Ventricles relax first, then the auricle

ABOUT THE AUTHOR

Huifen Lin is an associate professor in the Applied English Department, Kun Shan University, Taiwan. She got her Ph.D. in Instructional Systems from The Pennsylvania State University in 2006. Her research has been focused on the effect of visualizations and enhancement strategies on EFL learners' achievement.

Email: hf5612@mail.ksu.edu.tw

Tsuiping Chen is a Ph.D. student in the English Department in National Kaohsiung Normal University. Her research has been focused on EFL/ESL pragmatics and concordances.

Email: tsuiping0925@gmail.com

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