Effects of Visualisation and Advance Organisers in Reading Multimedia-Based Texts

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ABSTRACT

Recent advancements in multimedia systems to integrate text, audio, graphics, and video have created a new interest in using instructional strategies in a multimedia-based learning environment. In this light, this study explores the effect of two types of visualisations (static and animated) and advance organisers (descriptive and question) on EFL learners' reading comprehension in a multimedia context. To this end, a software program with four computer-based modules was designed to show texts with four instructional formats - texts with static visual embedded descriptive advance organisers, texts with static visual embedded question advance organisers, texts with animation embedded descriptive advance organisers, and texts with animation embedded question advance organisers. Eighty intermediate Iranian EFL learners, who were selected from three language institutes through a placement test, were randomly assigned to one of four computer-based instructional formats: the first group read texts with static visual embedded descriptive advance organisers, the second group had texts with static visual embedded question advance organisers, the third group read texts with animation embedded descriptive advance organisers, and the fourth group had texts with animation embedded question advance organisers. Once the EFL learners interacted with their respective instructional materials, they then took a reading comprehension test. The results revealed that the question type of advance organiser was more effective than the descriptive one; the animation type of visualisation was more effective than the static one and embedding animations with question advance organisers improved reading comprehension significantly. The findings imply the integration of advance organisers with computer-generated visuals in multimedia reading programs cue attention of L2 students to salient features conveyed in the reading texts and visuals.

Keywords: reading comprehension; advance organisers; visualisation; multimedia; instructional strategies

INTRODUCTION

The use of computer-based multimedia systems for education is increasing and growing emphasis has been given to the advancements of these systems in recent decades (Nazir, Rizvi & Pujeri 2012). As Brett (1995, p. 77) states, "increase in the speed, storage capacity and memory size of computers, together with developments in the sophistication of software, now enable computers to deliver video, sound, text and graphics". These advances in technology have also made it possible to integrate various media, including static and animated texts and pictures, aural narratives, photographs, and videos into learning materials

in a multimedia educational setting (Narayanan & Hegarty 2000, Pusack & Otto 1990). Nazir et al. (2012) posit computer-based multimedia environment has paved the way for more effective teaching and created a platform for applying Computer Assisted Language Learning (CALL), that is, "the sets of instructions which need to be loaded into the computers for it to be able to work in the language classroom" (Gunduz 2005, p. 193). A closer scrutiny of CALL studies also reveals a number of facts about the positive effects of computer technology on the development of different language skills (Chun 2006, Meihami & Varmaghani 2013). With a shift from traditional approaches of second/foreign language (L2) teaching to communicative ones in recent years, CALL, as a pedagogical tool, has received substantial support for endorsing and evaluating L2 learners' language skills, including L2 reading skill (Davies 2006).

Among the skills in foreign language teaching/learning, reading is one of the most important ones for English as foreign language (EFL) learners. "Reading comprehension has been a perennial issue and the subject of investigations in the realm of language teaching and learning as it involves complex processes" (Barrot 2013, p. 5). As Cheng (1996) states, without good reading proficiency, EFL learners face difficulty in their academic studies. Traditionally, reading has been considered as a passive or decoding skill, and given insufficient attention. The new trend considers reading as an interactive and complex process in which readers create meaning based on dynamic interaction of background knowledge, text information, and reading context (Carnine et al. 2006). In other words, "reading comprehension occurs on discourse level" and readers (rather than texts) carry the meaning in interaction with the texts which provide cues for readers (Zarrati, Nambiar, & Nor Rizan Tg Mohd Maasum 2014). This gradual transition from passive to active reading has drawn attention to the use of strategies to enhance reading comprehension skills. To be proficient readers, L2 learners should use various reading strategies in reading an academic text (Noorizah 2006). Furthermore, Christopher (1995) claims employing instructional strategies in CALL will lead to the higher quality of language learning, and, in the heyday of technology, multimedia can offer practical options for effective reading in the L2 context (Meihami & Varmaghani 2013). More specifically, integrating instructional reading strategies, such as visualisation(s) and advance organisers, into multimedia computer-based reading materials can be useful to both EFL teachers and students who want to tackle language problems in reading classes and promote reading processes in a new environment like in a foreign language context.

Visualisation is a technique for creating images, diagrams, or animations to communicate a message (Vasky 2007). Visualisation, typically presented as static in both print and computer-based environments, can now be animated or programmed to be dynamic to clearly present abstract notions invisible to us (Hegarty 2004). Applying visualisation through computer can be regarded as a visual aid to demonstrate meaning and systematise the material being taught; it can strengthen better understanding and higher retention of materials (Hart 2003). Another potentially constructive instructional strategy is advance organiser, which is a set of information given to learners prior to learning to help them in organising and interpreting new incoming information (Mayer 2003). Advance organisers can take many shapes including verbal descriptions (Chuang & Liu 2014), graphics (Tomlinson & McTighe 2006), questioning (Osman & Hannafin 1994), and aural descriptions (Chung & Huang 1998). Two famous such organisers are question organisers and descriptive organisers. It is, however, observed that learners encounter problems in reading comprehension when they have gaps in their content knowledge. For L2 learners with insufficient background knowledge of a subject matter, instructional strategies can be integrated into the course material. Instructional strategies through multimedia are assumed to be able to facilitate L2 readers' information processing, and to promote better cognitive encoding. The present study

then seeks to investigate the effectiveness of the instructional strategies of visualisation(s) and advance organisers in multimedia-based environment to improve L2 reading comprehension.

VISUALISATION

Cognitive load theory provides theoretical justifications for the use of visualisation in instructional materials. The basic tenet of the theory is that working memory is restricted, which imposes limitations on the amount of information which is required to be processed in working memory. The characteristics of learners, the nature of materials, and the characteristics of the instructional procedures are the issues that might determine the quantity of cognitive load stimulated on working memory (Marcus, Cooper & Sweller 1996). Levin and Mayer (1993) remind us materials that have precise information, such as visuals which focus on essential elements of content, would diminish cognitive load on working memory and, consequently, promote comprehension.

Dual-coding theory, sometimes referred to as a theory of mental imagery, also provides further theoretical justification for visual presentation. It can be contrasted with theories which assume that all cognition has a common, abstract code. According to this theory, cognition involves the activity of two distinct sub-systems, a verbal system, which is related to language, and a nonverbal system, which primarily deals with non-linguistic objects or events such as image and pictures (Paivio 2007). Mayer and Moreno (2002) posit the process of meaningful learning relies on selecting, organising, and then attaching of information in both visual and auditory memory, and dual coding of information in both textual and visual forms will enhance learning. The visual materials that activate both nonverbal and verbal systems may decrease cognitive load in working memory, hence providing more capacity for process of learning (Yang, Andre & Greenbowe 2003).

Several empirical studies support the use of visualisation in language teaching or learning and reading comprehension. For instance, Omaggio (1979) conducted a study to examine the role of visualisation in the reading comprehension of a French text at the Ohio State University. The results of his study showed that providing visual contexts effectively improved the recall of factual knowledge, that is, those L2 students who received visualisation in the French text performed better in reading comprehension than those who received only the text. In another study, Zavala (1999) selected 129 EFL learners and divided them into experimental and control groups. The experimental group was provided with text-plus-illustration while the control group received a text-only. Results were consistent with the tenet of dual-coding theory, demonstrating that the experimental group who read the story with pictures performed better than control group who did not. Zavala's finding supported the results of the study by Chun and Plass (1996) on second-year German students at three universities in California. They showed that visual materials aided overall reading comprehension of German texts and, more specifically, the annotations of vocabulary items (consisting of both visual and verbal information) helped more than verbal information-only in reading comprehension.

Research conducted by Guerrero (2003) further strengthens the belief that visualisation is a powerful means of improving levels of comprehension and recall. Using a four-week instruction in visualisation techniques with a small group of second grade students, Guerrero observed that 60% of the research subjects showed progress in their English reading comprehension. Furthermore, Parsons (2006) attests to the benefits of using visualisation as a tool to engage young readers to fully experience the realm of story. She found that visualisation allowed fourth-grade children readers to feel that they were present in the story world or that they had actually become one of the characters.

More recently, conducting research on the role of visualisation in EFL learners' reading comprehension and recall of short stories, Ghazanfari (2009) selected two groups of EFL undergraduates, attending a short story course. The experimental group was provided with visual materials (before reading, while reading, and after reading a short story), while the control group did not receive any visual materials. Results revealed that the experimental group had a significantly better performance than the control group in the process of reading short stories. Erfani, Ranmehr and Davari (2012) also investigated the role of visualisation in the reading comprehension of Iranian students in an English for Specific Purposes (ESP) course. Two homogeneous groups of thirty served as the experimental and control groups where reading materials were taught through visualisation and the conventional method common in Iranian ESP setting. The findings showed the advantage of using visualisation in promoting ESP reading comprehension ability of university students. Likewise, Sam and Rajan (2013) who trained a number of ESL (English as a second language) middle school language learners to utilise graphic organisers to decode information from reading passages reported that visualisation improved English reading comprehension.

While the use of visualisation in L2 reading has been supported by much empirical research, the research conducted so far on the effectiveness of types of visualisation remains rather unclear about the best type of visualisation. Some researchers (Mayer, Hegarty, Mayer & Campbell 2005, Schnotz, Bockheler & Grzondziel 1999, Tversky, Morrison & Betrancourt 2002) demonstrated that animation was an ineffective strategy, compared to other types, in learning. For instance, Schnotz, Bockheler, and Grzondziel (1999) conducted a research examining learning from texts and pictures together with an analysis of possible effects of animation and interactivity on knowledge acquisition. They selected 40 university students who were assigned to two groups: one group was given hypertext with interactive animated pictures and the other group with static pictures. Both were asked to do some simulation tasks. Results revealed that learning with interactive animated pictures did not facilitate the performance on the mental simulation tasks. Assuming that animation would have a superior effect over static visualisation, Mayer, Hegarty, Mayer and Campbell (2005) conducted a research to investigate the effect of annotated illustrations on psychology students' retention and test performance at the University of California. The subjects had either 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 worked. Results demonstrated the students receiving static diagrams with text scored higher on four of the eight tests than those who received the animation with narration.

On the contrary, some research has supported the superiority of animation over other types of visualisations (static visualisation). Hanley, Herron and Cole (1995) compared the effects of two visual advance organisers (video and pictures plus teacher narrative), on the comprehension of a passage in a foreign language. In the video group, an advance organiser was presented by a video clip whereas, in the comparative group, it was presented by four static pictures and teacher's narration in the target language. The findings of the study supported the use of animation as an instructional strategy to introduce a reading passage. Al-Seghayer (2001), who provided ESL students with reading a narrative English text with a variety of annotations for words in the form of printed text, graphics, video, and sound, also reported that a video clip was more effective than still pictures to promote the comprehension of words in reading texts.

Further research on the learning outcomes of using instructional animations and static images has demonstrated the equal effectiveness of static and animated illustrations as regards technical documents. For instance, Boucheix and Schneider (2009) investigated the presentation format on the comprehension of the functioning of a three-pulley system on a computer screen among 62 undergraduate students attended a compulsory Psychology

course. The results of their experiment indicated that both animation and static frames could enhance the comprehension of the technical document concerning the functioning of the pulley mechanical system depending on the level of user-control and condition of presentation. In sum, the review of literature, to some extent, shows the inconsistent results regarding the role of animation and static visualisation across studies.

ADVANCE ORGANISERS

Ausubel's theory of meaningful learning provides theoretical justification for advance organisers. According to Ausubel, advance organisers direct attention to what is important in the coming material, highlight relationships, and provide a reminder about relevant prior knowledge (Woolfolk, Winne, Perry & Shapka 2010); they help to connect new materials with prior learning (Schunk 2008). Empirical research has provided further evidence of the positive effects of various types of advance organisers to facilitate language learning, in general, and reading comprehension, in particular. Herron (1994) conducted an experiment to investigate the effectiveness of using a verbal advance organiser that outlined major scenes from a video. He intended to see whether students' listening comprehension of a foreign language (English) video would be facilitated by the use of an advance organiser. Herron demonstrated that learners' comprehension of a foreign language could be improved by providing an advance organiser in the form of a short, written summary of principal scenes in the video prior to the presentation of instructional materials.

In another study, Evans (2003) explored the effect of graphic type of advance organisers on expository texts in English for Japanese readers. He found that student generated graphic organisers led to meaningful learning, and enhanced reading comprehension. More recently, Mohammadi, Moenika, and Zahed-Babelan (2010) looked into the role of advance organisers in L2 learning in two classes (selected as experimental and control groups) at Ardabil Islamic Azad University. In the experimental group, English was taught through the use of advance organisers for two months using picture-word, block-word and semantic mapping. They discovered that using advance organisers improved performance on the Test of English as a Foreign Language (TOEFL) significantly.

In sum, the related literature on visualisation has not been able to conclude very strongly that animated visualisation is more effective than static visualisation in learning. Moreover, the empirical research on visualisation and advance organiser strategies has documented the related effectiveness of different types of visualisations and advance organisers in different contexts. Yet, little research has so far compared the learning effects of static vs. animated visuals and descriptive vs. question advance organisers in a multimedia environment in L2 contexts. Most studies conducted in the multimedia environment (Kim & Gilman 2008) have either focused on the effects of text, audio, and graphic aids to help language learners' vocabulary development or scrutinised the effects of different types of multimedia glosses (Yanguas 2009) or annotations (Jones & Plass 2002) on language skills or vocabulary learning. Almost no study, to the best of the present researchers' knowledge, has ever compared the learning effects of static vs. animated visuals together with descriptive vs. question advance organiser strategies to explore reading comprehension of EFL learners in a computer-based multimedia environment. If animated/static visualisations are embedded with other instructional strategies such as descriptive/question advance organisers in a computer-based multimedia environment, this integration may smooth the path to better L2 reading outcomes. In other words, if this environment is brought to the L2 classroom, reading skill development may be witnessed. Given this gap in the literature, the purpose of the present study is to examine the effect of two cognitive strategies - visualisations (animation vs. static) and advance organisers (descriptive vs. question) - and their interactive effect on L2 learners'

reading comprehension in a multimedia context. In line with the above mentioned objectives, the present study is an attempt to provide answers to the following questions:

1. Is there any significant effect of visualisation (static vs. animation) on L2 learners' reading comprehension of multimedia-based texts?
2. Is there any significant effect of advance organisers (descriptive vs. question) on L2 learners' reading comprehension of multimedia-based texts?
3. What is the relative effect of combining advance organisers with visualisation on L2 learners' reading comprehension of multimedia-based texts?

METHOD

PARTICIPANTS

For the purpose of this study, 80 intermediate EFL learners were selected non-randomly from a larger sample of 120 EFL learners from three private language institutes in Iran through a placement test. They included both male (n = 30) and female (n = 50) students whose ages ranged from 18 to 24, with Persian as their L1. The participants had learnt English for 6-7 semesters in the English language institutes; so it was assumed that the participants were familiar with reading tasks. The selected participants were divided into four groups of 20, namely animation plus question advance organiser group, animation plus descriptive advance organiser group, static plus question advance organiser group, and static plus descriptive advance organiser group.

INSTRUMENTS AND MATERIALS

To collect data, this study made use of two instruments and a software program. The first instrument was the Oxford Placement Test (OPT 2007), which consisted of 50 multiple choice questions, assessing students' knowledge of key grammar and vocabulary, 10 graded multiple-choice reading questions, and an optional writing task, assessing students' ability to produce the language. This study used reading and language use parts of the OPT to select a group of intermediate-level EFL students.

The second instrument was a reading comprehension test, developed and embedded in the software program to assess the participants' reading comprehension ability. This test consisted of 31 true/false and 49 multiple-choice items about the main points of the texts i.e., questions about the process of water and carbon cycle (see the sample of true/false and multiple-choice items in the reading comprehension test in Appendix). The scores in the reading test could range from 0 to 80.

The validity of the reading comprehension was examined through content and concurrent validity. The content validity was ensured through the development of a test blueprint (item specifications) by two experts and piloting the test. Furthermore, the test was administered to 30 EFL participants who were similar to the participants in the main study. They answered the reading part of paper-based TOEFL and the researcher-made reading test concurrently. The results of Pearson product moment correlation revealed that there was a significant and strong correlation between the reading test and the paper-based TOEFL results ($r = .85$, $*p < .01$). Moreover, the internal consistency of the reading test, estimated through conducting Cronbach's alpha, was acceptable (0.85).

A software program with four computer-based modules was designed with the help of a web designer to present multimedia-based reading texts. This software program, installed on Windows and designed by C# (C sharp), was able to show a text with four formats: animation embedded question advance organisers, animation embedded descriptive advance organisers,

static visual embedded question advance organisers, and static visual embedded descriptive advance organisers. The modules used in the present study consisted of three different phases (pre-reading, reading, and post-reading). In the pre-reading phase, information was presented in the form of question and descriptive advance organisers. In the reading phase, two different reading texts were provided with either static or animated visuals; the texts were selected based on the length, genre, difficulty or readability. The reading texts - water cycle and carbon cycle - contained about 700 words and the readability of them were measured through Flesch-Kincaid readability test, which displayed the Flesch Reading Ease scores of 58 and 60 respectively, which were neither very easy nor very difficult for the intermediate-level EFL learners. In the post-reading phase, reading comprehension items were presented.

PROCEDURES

The Oxford Placement test (OPT) was given to the 120 EFL students from the above-mentioned language institutes. Following guidelines of the test (Edwards 2007), those who scored above 31 on grammar and language use and above 8 on reading part were selected as intermediate-level EFL participants (n = 80) to take part in the main study. Meanwhile, in order to further ensure the homogeneity of the participants, they were randomly assigned to two groups and their OPT scores were compared through *t*-test. The results showed that there was no significant difference between two randomly selected sets of reading scores ($t = .750$, $p > .05$). To investigate the research questions of the study, they were randomly divided into four groups, each with 20 EFL participants: the first group was provided with multimedia-based texts with static visual embedded descriptive advance organisers (henceforth S+D); the second group was given multimedia-based texts with static visual embedded question advance organisers (henceforth S+Q); the third group was provided with multimedia-based texts with animation embedded descriptive advance organisers (henceforth A+D), and the fourth group was given multimedia-based texts with animation embedded question advance organisers (henceforth A+Q).

In the school language labs, the participants were first asked to complete the consent and background form, provided by the software. Secondly, in the pre-reading phase, the participants were provided with two types of advance organisers: the S+D and A+D groups were asked to select descriptive organisers, and the S+Q and A+Q groups were required to select question ones before reading the two texts. Thirdly, they were provided with the reading texts embedded with either static or animation visuals by clicking on either static or animation options displayed on the computer monitor (see Appendix for a sample shot of the text with visualisation). Fourthly, the reading comprehension test, including true/false and multiple-choice items, was administered. Fifthly, the scores were reported by the software program with one credit (1 point) assigned for each correct answer. Finally, SPSS (version 20) was utilised to analyse the data to answer the research questions of the study.

RESULTS

Table 1 reports the descriptive statistics of the reading comprehension scores for the four groups of the study (S+D, S+Q, A+D, and A+Q). As demonstrated in Table 1, the S+D group received the lowest ($M = 54.15$) reading comprehension mean score, meaning that integrating the still (static) visuals with the descriptive type of advance organisation did not lend much assistance to the EFL participants in reading comprehension. Moreover, the A+Q group received the highest ($M = 62.30$) reading comprehension mean score, indicating that integrating the animation with the question type of advance organiser assisted the EFL learners more in gaining better reading comprehension scores.

TABLE 1. Reading Comprehension Scores

Groups	N	Minimum	Maximum	Mean	Std. Deviation
S+D	20	44	62	54.15	4.99
S+Q	20	44	63	55.70	5.55
A+D	20	55	69	61.65	4.02
A+Q	20	52	70	62.30	4.77

To examine the first research question of the study, which was intended to see whether the type of visualisation had any significant effect on L2 learners' reading comprehension, the reading mean scores of those participants who read the texts embedded with the static visualisations and those who read the texts embedded with the animation visualisations were obtained. The mean score of those participants who had the static visualisations (M = 54.92, SD = 5.27) was lower than those who had the animation visualisations (M = 61.97, SD = 4.40). The latter had a better performance on the reading comprehension test. To see if this mean difference (7.05) was statistically significant and, consequently, address the first research question, independent sample t-test was run. The results are summarised in Table 2.

TABLE 2. Independent t-test for the Effect of Type of Visualisation

	F	*Sig.*	*t*	*df*	*Sig.*	Mean Difference	**95% Confidence Interval**	
							Lower	**Upper**
Equal variances assumed	2.71	.110	-6.51	78	.000	-7.05	-9.20	-4.89

As demonstrated in Table 2, the t-test value was 6.51, which was statistically significant at .05 ($*p < .05$). That is to say, the type of visualisation as an independent variable had a statistically significant effect on the performance of the EFL learners in the comprehension test in a multimedia setting. The effect size for the t-test was calculated to be 0.60, which was a large effect magnitude (Larson-Hall 2010). In other words, this effect size was large enough to interpret that the difference between the two different types of visualisations (static vs animation) was meaningful so as to explain the above results as a support for the use of animation to facilitate the EFL participants' reading comprehension.

The second research question examined whether the type of advance organisers had any significant effect on L2 learners' reading comprehension. To address this question, the mean scores of those participants who had the descriptive advance organisers (M = 57.9, SD = 4.50) and those who had the question advance organisers (M = 59, SD = 5.16) were compared through another independent t-test. The results of the t-test are reported in Table 3.

TABLE 3. Independent t-test for the Effect of the Type of Advanced Organisers

	F	***Sig.***	***t***	***df***	***Sig.***	**Mean Difference**	**95% Confidence Interval**	
							Lower	**Upper**
Equal variances assumed	.020	.867	-4.82	78	.004	-1.10	-3.76	1.56

As indicated in Table 3, that there was a statistically significant difference between the mean scores of those who had the descriptive advance organisers and those who had the question advance organisers, t (78) = 4.82, $*p < 0.05$; those who were provided with the descriptive advance organisers performed better on the reading comprehension test. That is to

say, the results lend to the interpretation that the type of advance organisers had an effect on the EFL learners' reading comprehension. However, the effect size of the *t*-test was medium (0.24), stressing the need for caution. In other words, the expected variance in the reading comprehension scores explained by the effect of type of advance organisers was not very much. In sum, the embedded questions inserted before the multimedia texts had an effect on improving reading comprehension of the texts in a multimedia settings, but the effect was not very large.

In order to address the third research question of the study, which focused on the combining effect of advance organisers and visualisations on L2 learners' reading comprehension, a one-way ANOVA was performed on the reading comprehension score among four groups of S+D, S+Q, A+D, and A+Q. The reading comprehension scores were considered as dependent variable and the group was considered as independent variable in the analysis; these four groups were different in either one or two types of instructional strategies (advance organisers and visualisations). The results of the ANOVA are summarised in Table 4.

TABLE 4. ANOVA on Reading Comprehension Scores of Four Groups

Total Scores	Sum of Squares	*df*	Mean Square	*F*	*Sig.*
Between Groups	1022.300	3	340.767	14.408	.000
Within Groups	1797.500	76	23.651		
Total	2819.800	79			

The data in Table 4 showed that there was a statistically significant difference among the reading scores of the four groups of the study, F (3, 76) = 14.40, $*p < .05$). The above results could suggest a combining effect of the type of visualisation and advance organiser. As displayed in Figure 1, there was a noticeably significant increase in reading comprehension scores (5.95) from the S+Q group to the A+D group of the study ($*p < .05$). These two groups were different in both advance organiser and visualisation types. This shows that integrating the animation with the descriptive type of advance organiser increased the performance of the participants on the reading comprehension test. In addition, the greatest mean difference (8.15) was obtained between S+D and A+D groups, which were also different in both advance organiser and visualisation types; the A+Q group significantly outperformed the S+D group ($*p < .05$). That is to say, the integration of the animation with the question type of advance organiser resulted in the participants' better performance on the reading comprehension. Thus, the aforementioned results lend themselves to the interpretation that there exists a positive combining effect of the type of visualisation with the type of advance organiser to improve the reading comprehension of the EFL learners.

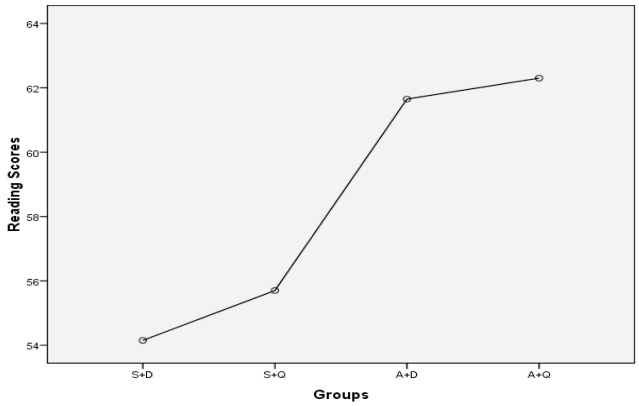

FIGURE 1. The Polygon Graph of the Performance of Four Groups

DISCUSSION

The results of this study, firstly, showed that the use of visualisation had a positive effect on English reading comprehension. It can be argued that the EFL participants who were provided with the visual materials kept content materials in memory better due to repetitive encoding. The visual images in the multimedia environment had possibly activated both visible and verbal systems of the brain and decreased cognitive load in their working memory, providing more capacity for processing information in the reading texts. Furthermore, it can be postulated that the participants exposed to visual materials processed information in the multimedia texts through two channels rather than a single channel. As Bagui (1998) states, the verbal code can be complementary to the nonverbal code and both codes can act as a corresponding form of presenting information. Most likely, dual coding of information, in both textual and visuals, embedded in the software program, enhanced the learners' comprehension. The above finding receives support from the findings of the previous research (Erfani et al. 2012, Guerrero 2003, Parsons 2006), who demonstrated that visuals enhanced the reading comprehension of English texts (ESP texts and stories). Sam and Rajan (2013) also demonstrated that visuals could help ESL students decode information from reading passages.

Secondly, the findings of the current study support greater effectiveness of animation over static visualisation. As Boucheix and Schneider (2009) state, the discontinuity of the movements in static visuals can increase cognitive demands, but, according to Rieber and Kini (1991), when learners use animated graphics, there is less need to make a mental image of the events being focused on. Hence, misunderstanding is reduced by the creation of false mental images, resulting in better processing of upcoming information. This might have been an advantage in the animation groups, leading to faster and better processing of information in the texts. That is to say, the animations did not induce extraneous cognitive load on the part of the EFL participants. This assertion can be supported by Hays' (1996) and Rieber, Tzeng, and Tribble's (2004) findings on the superiority of animation over static visuals. The above results, however, challenge Mayer et al.'s (2005) idea that only static illustrations effectively reduce extraneous cognitive load. The addition of animation appeared to have acted as an engaging tool, assisting the EFL participants to attend to the crucial information in the multimedia texts.

Furthermore, the inclusion of two varied types of advance organisers, in general, made a difference in reading comprehension of multimedia-based texts. It is clear that with the addition of question advance organisers, English reading comprehension improved more effectively. The reason behind the superiority of question advance organisers might be due to the intrinsic nature of the questioning strategies. As Osman and Hannafin (1994) state, questioning strategies can be employed to make learners participate in deeper cognitive information processing and, consequently, expand their learning and deepen understanding. The effectiveness of question advance organisers in the present study can be attributed to the "explicitness of the questions [and] relationship to instruction" (Osman and Hannafin 1994, p. 5) which might have made the participants "focus on question-specific information" (Osman and Hannafin 1994, p. 5). Organisers in the form of short statements may stimulate lower cognitive process, not drawing enough attention from learners. Questions, on the other hand, become the focus of learners' attention. Thus, perhaps the participants who used question advance organisers concentrated on the important parts of the reading texts and established connections between the new information and their existing knowledge, leading to meaningful understanding. Of course, advance organisers were used to produce cognitive structure for newly information, but possibly some of the EFL participants could not establish

connection between their prior knowledge and new information, hence having a less available working memory capacity when performing on the reading comprehension test.

However, as the findings of this study indicate, if advance organisers such as descriptive and interrogative organisers, are used together with different types of visualisations, they will smooth the path to better reading gains than using advance organisers per se. Contrary to what Owens and Dwyer (2005) suggest, combining supplementary visual and verbal information do not distract learners from focusing on important concepts. As the results of this study indicated, when the animation type of visualisation was used with the advance organisers, particularly the question type of organiser, additional support was provided for EFL learners' comprehension of the texts. The question type of advance organisers could prepare the EFL readers' cognitive structure for new and unfamiliar schema and help them focus on relevant cues contained in either the texts or the visuals, so animations turned out to be more effective in the process of reading comprehension. Though the learning gain difference between the groups that received animated materials plus descriptive advance organisers and the groups that received animation plus question organisers was not great at best, it can cogently be argued that the EFL participants assigned to the animation plus question advance organisers concentrated better on significant information represented by the animation accompanying the texts.

CONCLUSION AND IMPLICATIONS

Recent developments in the field of educational technology have generated interest in exploring the role of different instructional strategies in multimedia learning environment. Among these new strategies, computer-generated visuals have gained popularity in recent years. Also, other cognitive and pedagogical strategies such as advance organisers have been designed to be integrated into various types of visuals to improve L2 learners' accomplishment. The current study focused on the effects of two types of visualisations (static vs. animated) and advance organisers (descriptive vs. question) regarding L2 reading comprehension in a computer-based multimedia learning environment. The findings revealed a significant effect for the type of advance organisers as well as the superiority of animations over static visuals in relation to the reading comprehension of the two English texts about water and carbon cycle; instructional animations appeared to encourage better retention of material content and processing of information in the reading texts. The above results also supported the greater effectiveness of question type of advance organisers. In other words, when the L2 participants were provided with question advance organisers prior to reading materials, they, in general, comprehended reading content more effectively. Furthermore, the findings of the present study indicated that when the instructional strategy of advance organisers was combined with the instructional visualisation strategy, the instructional effect was greater.

On the theoretical side, the findings of the current study about visualisations offer further support for dual-coding theory. When information is dually coded, there is little possibility of losing information in texts. On the pedagogical side, the above findings inform L2 teachers and materials developers to include visual elements, such as charts, diagrams, and images, in the L2 instructional materials to facilitate L2 reading comprehension. According to the above findings, when graphics are added to conventional L2 text-based materials, it will result in more effective L2 reading. Also, the results discussed above extend our understanding of advance organiser use in multimedia reading environments. The results that build on Ausubel's theoretical perspective reinforce the prior theory of meaningful learning, and, consequently, encourage L2 teachers to apply advance organisers in their

pedagogy. As Chen (2007) states, the original Ausubel's model was first developed for the face-to-face classroom context where the blackboard was the main teaching medium. The current study has expanded the advance organiser framework to a computer-based multimedia environment. The use of advance organisers can be a good teaching and learning practice in L2 reading programs in the context where reading comprehension can be enhanced with multimedia. The above findings imply that L2 students may benefit from using different types of advance organisers not only in a traditional classroom, but also in an ever-growing computerised multimedia learning environment. Furthermore, the results of this study suggest the integration of question advance organisers with visualised materials in L2 reading-based programs to cue attention of L2 students to salient features conveyed in reading texts and visuals; and propose instructors and course designers can use both to map out reading contents and activities in L2 reading programs.

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APPENDIX

SAMPLE OF ITEMS IN THE READING COMPREHENSION TEST AND A SHOT OF THE TEXT WITH VISUALISATION

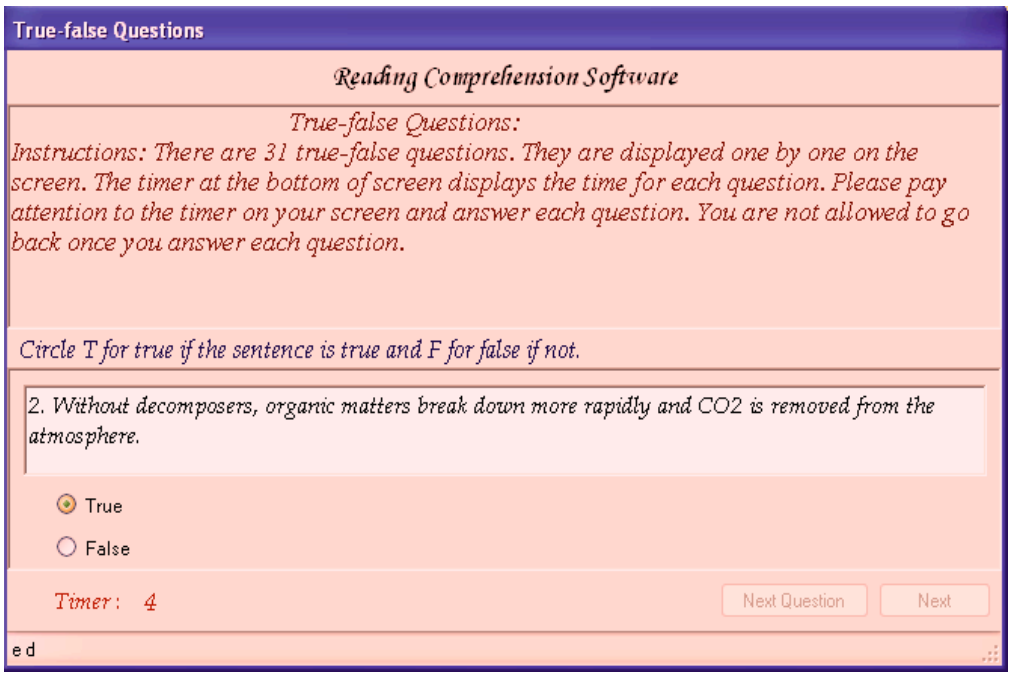

FIGURE A. Screenshot of True/False Item in the Reading Comprehension Test

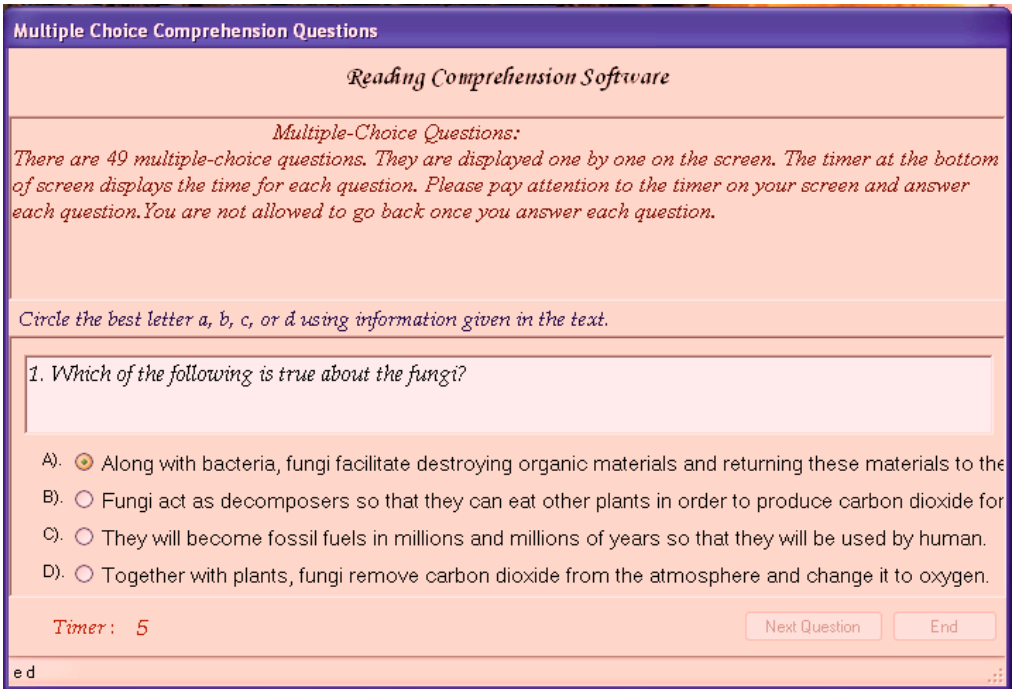

FIGURE B. Screenshot of Multiple-Choice Item in the Reading Comprehension Test

FIGURE C. Screenshot of Part of the Multimedia Text