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The impact of applying computer assisted concept mapping on EFL learners' reading comprehension

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ABSTRACT
The aim of this paper was to study the impacts of a type of learning strategy, which was computer-assisted concept mapping, on EFL learners' reading comprehension. The research question was whether computer-assisted concept mapping technique had any notable effect on EFL students' reading comprehension. To this end, students based on their scores in TOEFL proficiency test were divided into two experimental and control groups. A computer-assisted concept mapping learning strategy was presented to the experimental group learners. Through an independent sample t-test, it was proved that the computer-assisted concept mapping learning strategy improved the participants' reading comprehension in the experimental group.

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Introduction

Reading is obviously one of the most crucial skills and activities in any educational setting, especially in language classes. This importance is partially due to regarding reading not only as a great origin of information and an enjoyable activity, but also as a channel of reinforcing and boosting one's knowledge of the language (Rivers, 1981).

Reading comprehension skills, according to Sanders (2001), separate the "passive" and not skillful readers from the "active" ones. Skilled readers do not merely read; they have interactions with the text. Skilled readers, for instance, anticipate what is about to take place next in a story with the use of hints given in the text, devise questions about the main idea, message, or plot of the text, and monitor understanding of the sequence, context, or characters (Sanders, 2001). Numerous pupils that fight to learn how to read and become active readers are able, with proper guidance, to take care of their primary reading difficulties of becoming accurate decoders (Adams, 1990).

Adams (1990) described good comprehenders as fluent readers. Therefore, in order to comprehend better as to be a fluent reader, learners need to see the text formed and arranged in such a way that simply can be interpreted, and which is indicative of the relationships amid its ideas and concepts.

Tracing back to 1972, a research was carried out at Cornell University by Novak and Gowin, that children's scientific conceptual change processes were directed to monitor and investigate (Novak & Gowin, 1984). However, paper and pencil tests were not identified as being able to measure children's understanding validly by Novak and Gowin. Therefore, Novak was built up by the experience to establish a prototype of concept map in the role of an assessment tool which allowed the students to clearly express their changing degrees of understanding and track their conceptual changes over time. When a leaner is processing information, his/her meta-cognitive awareness can be stimulated by concept mapping, so that it helps the learner to create a suitable monitoring strategy and also to expand and boost the use of retrieving and memorizing knowledge (Novak &Gowin, 1984). A more systematic and organized way is offered to the reader to make clear the essential and main concepts of a text. In the process of drawing concept maps using traditional paper-pencil methods two restraints are remarkable. First, a concept map including various concepts might be cubersome to be used without difficulty and easily (Anderson-Inman &Zeitz, 1993). As the second point, providing quick feedback to each student while using the traditional paper-pencil method, is not convenient (Reader & Hammond, 1994).

The limitations which are posed by the application of the traditional paper and pencil method are gradually removed with the passage of years by the swift development of technology and computer-assisted concept maps are the ones that are offering the solutions. Integrating computer-assisted learning with concept mapping as a learning strategy sets about learners to construct concept maps that assist in the progress of modification of nodes and links and also make it easier and quicker to draw and revise the structure (Reader& Hammond, 1994). Moreover, the processes can be recorded in the database of the computers as the learners are constructing the maps and it is made easier for the instructors to persue the their learning behavior and further analyze the database (Liu et al, 2009). By applying computer-assisted concept mapping, building a proper monitoring strategies is possible for the students and also they can call up the content of an article that's reading might be cut off due to activities such as checking the dictionary and the like . They can also review the content, and guess or infer the meanings of vocabularies when they understand the article as the whole through concept mapping.

Liu et al. (2009) noticed the disparateness of the research results on the effect of computer-assisted concept mapping on learners' reading comprehension ability of various levels of language proficiency. Wu and Zeng (2003) posed that learners with high level of language proficiency had greater reading comprehension ability and concept mapping than those with low proficiency. Although Novak, Gowin, and Johansen(1983) stated that by using concept maps learners in general can gain benefits, the question of an appropriate proficiency level for the application of computer assisted concept mapping remains diverging. Different studies have been done for reaching a finite answer, but various results have been obtained.

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Concept Mapping Reading Comprehension Strategy

According to Ausubel (1963), as a learner, consciously and explicitly, connects the novel knowledge to the approperiate and corresponding concepts or propositions which she/he already owns, meaningful learning takes place. Storing new information in long-term memory while associating it with identical relevant pieces is how meaningful learning happens. while rote learning is in no way similar since there is little or no striving to make information meaningful or even to understand it in terms of things which are already known. So even if such information is stored in long-term memory at all, it is not connected to any other piece, and is seperated from other relevant ones, therefore it becomes hard and sometimes impossible to retrieve it. Among the advocates of meaningful learning theory, Novak and his coworkers (Novak, 1981) were especially attracted to the variations between rote and meaningful learning, and also the role of prior knowledge in learning. According to Robinson (1998), Novak initiated studying the techniques of concept mapping, based on the theory behind David Ausubel's advance organizers in 1960. Novak in his book , *Learning How to Learn*, in 1984, asked a basic question, "Howcan we help individuals reflect upon their experience and to construct new, morepowerful meanings? " and in a search to the answer to the question, he built his view and introduced the concept map upon Ausubel's theory.

Novak (1990) defined concept map as "a graphical representation, in which a nodule of information representing a concept has lines or arrows linking to smaller nodules showing associative relationships within the concept map". The concept map can categorize the information nodule and the links which are representing temporal or causal associations between concepts. Plotnick (1997) argues that concept maps can assist its reader to apprehend the gist of a basic concept and the way it interrelates to prior knowledge. In other words, the concept map describes the association between the key concept and the linking ideas which are generated from that concept.

Liu et al. (2009) mentioned while adopting concept mapping in reading, learners need to confirm the concept of a topic, working from its characters to words, to sentences, and paragraphs, and to arrange the concepts around a main concept. Then learners have to connect and join the connection between some concepts, next understand the essay as a whole. This construct process is bottom-up reading comprehension. In addition, when mapping, learners use personal prior schema in order to organize the new message so that the learners can develop a new schema actively (Ruddell& Boyle, 1989). After mapping, the learners can also review the relationships between concepts. This process of the reader's utilizing prior schema to construct meaning has the positive effect of a top-down reading model.

Robinson (1998) posited that Novak's concept mapping has quickly gained momentum for use in all fields of education. Unlike the theory presented by Ausubel (1963), teachers are no longer doing the prior constructing of the visual representation. Now students are taking an active part in their learning. Novak's concept mapping allows students to talk through their ideas on the concept being presented and sharing those ideas with their peers. Using this process enables both the auditory and visual learner by providing a bridge connecting the visual patterns and relationships. Through student manipulation of the information, the opportunity is increased for understanding the concept (Reader & Hammond, 1994).

Computer-Assisted Concept Mapping

For many years, concept maps were drawn by hand. Iterating through revisions of a concept map was cumbersome and time consuming for both students and teachers. The introduction of personal computers enabled the development of software programs that facilitated the construction of concept maps. Initial versions of concept mapping programs, however, did not enhance the power of the tool – they were limited to displaying a concept map on the screen (Novak, 2006).

Robinson (1998) mentioned that there were drawbacks to the use of a concept map that the student designed by hand. If, during brainstorming to generate ideas, thoughts begin to flow spontaneously, the concept map could become extremely cumbersome and lose its advantage. Continually erasing the hand-created concept map to replace and update information causes the student to become confused, hampering reading retention. Students with learning disabilities are easily disconcerted and frustrated, and are prone to give up quickly. The hand-drawn concept map requires a carefully planned and edited layout. If not, it results in a jumble of cluttered, unmanageable and incomprehensible information for the student. This aspect of hand-drawn concept maps must be adapted with efficacy, while leaving the advantage of increased comprehension through the use of concept maps.

Alpert and Grueneber (2001) mentioned that the traditional way of constructing concept maps used paper and pencil, but with the rapid development of Information and Communication Technologies (ICT), a number of computer-assisted concept mapping systems have been proposed. The transparent benefit of concept mapping tools is their ability to elicit the right level of complexity and detail in the student's exploration (Kommers, 1995). Programs such as SemNet, Learning Tool, Inspriation, Mind Mapper, and many others enable learners to interrelate the ideas that they are studying in multidimensional networks of concepts, to label the relationships between those concepts, and to describe the nature of the relationships between all of the ideas in the network. Combining computer-assisted learning with concept mapping as a learning strategy leads learners to construct concept maps actively and to achieve positive effects in students' attitudes in learning (Asan, 2007).

Tsai, Lin and Yuan (2001) developed and evaluated aweb-based concept map testing system for science students. Thirty-eight Taiwanese high school students were involved and it was found that their performance on the system was not significantly related to their achievement as measured by traditional standard tests. However, their views about the use of the system, in general, were positive. An analysis of students' future use of the system and their motivation and learning strategies revealed that those students with better critical thinking ability showed more willingness to use the online testing system. Moreover, students with high test anxiety showed a preference to be tested through the system. In another study, Schaal, Bogner and Girwitdz (2010), applied an interdisciplinary hypermedia assisted learning unit for the development of cooperative learning. They used concept mapping for the assessment and applied a pre-test/post-test design. In their study, 106 students cooperated by working in pairs for six lessons. Learners worked cooperatively in dyads and constructed computer-supported concept maps which were analyzed by specific software. After the treatment, the results showed the acquisition of higher-order domain-specific knowledge structures and indicated successful interdisciplinary learning through the hypermedia learning environment.

In educational environments, a number of computer-based concept mapping tools have been reported by researchers

(Gorodetsky, Fisher, & Wyman, 1994; Flores-Mendez, 1997; Gaines & Shaw, 1995) and there are software programs and commercial products for concept mapping activities. Computerized concept mapping software programs can be easily corrected, and they help learners construct concept maps very fast. The application of computerized mapping programs assists instructors and learners to interact efficiently (Anderson-Inman & Zeitz, 1993;Novak, 1995). Furthermore, it is possible by the use of computers to track and record learners' concept-constructing processes, analyze their thinking patterns, and resolve test results (Foegen & Hargrave, 1999). Among the large number of computer softwares for concept mapping, "Inspiration" was the program compatible with the notion of concept mapping to assist learners with English reading. It is a software which mixes diagrams and outlines to make a concept map. Novak (2006) mentioned that programs like Inspiration popularized the application of concept mapping in elementary school education by letting children to add pictures and clipart to concepts easily. Software programs such as Knowledge Manager and Smart Ideas have also taken advantage of technology to make the construction of concept maps easier and more convenient. However, it was the marriage of the concept map and the Internet that launched a completely new world of applications and uses for concept mapping.

Due to the crucial importance of reading comprehension in EFL contexts, any technique claiming to contribute to reading comprehension will logically be worthy of research. Taking the aforementioned issue in consideration, this study aims at exploring the following research question:

Does computer assisted concept mapping technique have any significant effect on EFL students' reading comprehension?

Method

Participants

The participants were selected from English Language Learning Center (A language school under the supervision of Ferdowsi University).In this study, participants were60 male and female students ranging in age from18 to 23and they were selected from among 90 participants (55 girls and 35 boys) based on the scores they obtained in a proficiency test of English.All participants were higher intermediate learners of English and after administering the proficiency test, they were randomly assigned to two groups of 30 as the experimental and control groups.

Instrumentation

The following instruments were used in this study in order to obtain the relevant data to answer the research question.

A. TOEFL proficiency test
B. Reading comprehension test as a pre-test
C. Computer-assisted concept mapping software program
D. Reading comprehension test as a post-test

A. In order to come up with a homogeneous group of subjects in respect to their general English proficiency, a sample of TOEFL test (Phillips, 1996) was administered. The proficiency test was composed of three sections: three passages followed by 30 reading comprehension questions, 20vocabulary and 25grammar questions in multiple-choice form. The allocated time to answer the test was80 minutes. The reliability of the test was calculated through KR-21 formula and it turned out to be0.78.

B. The pre-test included five reading passages of Reading Comprehension section of the simulated TOEFL (Philips, 1996), each one followed by ten to 12 multiple-choice questions. These questions were presented in the form of multiple choice questions. Time allocated for the whole test was70 minutes for a total number of 55questions. The passages readability grades were measured according to Flesch reading ease formula since it is a general formula suitable for all kinds of texts. The reliability of the test through KR-21 formula turned out to be 0.73.

C. The participants went through computer assisted concept mapping technique via the use of computer program, Inspiration Software. They worked on five passages from TOEFL sample readings (Philips, 1996) and draw their concept maps.

D. The passages of the post test were different from the pre-test, but the number of passages and questions, the questions forms, and time allocation were similar. The readability grade of the texts remained the same. The reliability of the post-test was calculated through KR-21 formula and it turned out to be 0.75.

Procedure

First, the participants were homogenized with respect to their general proficiency in English. In order to evaluate the participants' reading comprehension ability and obtain confidence that there was no significant difference between the experimental and control groups' reading ability, Reading Comprehension section of the simulated TOEFL test (Phillips, 1996) as the pre-test was administered. After that, the treatment started. Participants started to draw their concept maps for each of the passages during the treatment. While adopting computer assisted concept mapping in reading the passages, they needed to confirm the concept of a topic, working from its characters to words, to sentences, and paragraphs to arrange the concept maps around a main concept. When mapping, they applied personal prior schemata to organize the new message so that they could develop a new schemata actively (Ruddell& Boyle, 1989).After mapping, the participants could also review the relationships between concepts. The experiment continued for 10 weeks. Each session was about 90 minutes for both groups. In an extra session, they attended a one day workshop conducted by the researchers on computer assisted concept mapping in their computer laboratory. They were also provided with handouts that included an introduction to concept mapping, a list of characteristics of concept maps, and examples of well-constructed and poorly constructed concept maps. After attending the workshop, the experimental group used computer assisted concept mapping techniques for reading comprehension.

The participants were asked to complete their concept maps using the following procedure:

1. Select major concepts to be included in the map.
2. Rank or organize the list of concepts from the most inclusive to the most concrete and specific. In general, there should be fewer abstract concepts than concrete ones.
3. Cluster the concepts according to two criteria: concepts that function at a similar level of abstraction (horizontally related) and concepts that interrelate closely (hierarchically related). In hierarchically related concepts, one concept dominates a group of other concepts but in horizontally related concepts, all concepts are at the same level of importance and they are subcategories of the dominant concepts.
4. Arrange the concepts in a configuration to depict relationships among the concepts. This can be the most intense stage requiring rearranging, rethinking, reclustering, adding prior knowledge, and searching for input.
5. Link related concepts with lines and label each line with a logical connective (Novak, 2006).

The reading passages constituted the instructional materials during the treatment.

The researchers adopted the scoring system of Novak and Gowin (1984) for the concept map assignments that the subjects had drawn.

Table 1. Group statistics for the proficiency test

Grouping	N	Mean	Std. Deviation	Std. Error Mean
Experimental Group	30	63.87	5.050	.922
Control Group	30	62.90	4.971	.908

Table 2. The results of the t-test for the proficiency test

	Leven's Test for Equality of Variances		t-test for Equality of the differences				
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference
Equal Variances assumed	.077	.783	.747	58	.458	.97	1.294
Equal Variances not assumed			.747	57.99	.458	.97	1.294

Table 3. Group statistics on the pre-test

Grouping	N	Mean	Std. Deviation	Std. Error Mean
Experimental Group	30	42.37	5.327	.973
Control Group	30	42.87	4.911	.897

Table 4. The results of the t-test for the pre-test

	Leven's Test for Equality of Variances		t-test for Equality of the differences				
	F	Sig.	T	df	Sig. (2-tailed)	Mean difference	Std. Error difference
Equal Variances assumed							
Equal Variances not assumed			.378	7.621	.707	-.50	1.323

Table 5. Group statistics on the posttest

Grouping	N	Mean	Std. Deviation	Std. Error Mean
Experimental Group	30	46.97	4.098	.748
Control Group	30	43.57	5.022	.917

Table 6. The results of the t-test for the posttest

	Leven's Test for Equality of Variances		t-test for Equality of the differences						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95% confidence interval of the difference	
								Lower	Upper
Equal Variances assumed	1.577	.214	2.873	58	.006	3.40	1.183	1.031	5.769
Equal Variances not assumed			2.873	-55.765	.707	-.50	1.323	-3.148	5.771

The researchers classified scoring according to the ability of the participants for topic assigning (one point for a meaningful assigned topic), consideration of hierarchical level (five points for a valid hierarchy), drawing cross links (ten points for every valid cross link), and setting examples (one point for every example). The highest possible score for every assignment was 100.

While the experimental group was adopting the computer-assisted concept mapping reading technique, the control group was using the same articles as reading materials but they did not receive any instruction related to the use of concept maps. Each session they were provided with one reading text. The researchers began each session by eliciting the participants' information about the text by reading its title, then reading the text aloud while the participants listened. At the end, researchers asked the students to go through the text silently and individually and then posed some questions for them to check their comprehension. The researchers also provided them with the definition of new vocabulary items and taught the grammar of the text explicitly.

At the end of the treatment period, all the participants took the same posttest. The passages of the test were different from the first pre-test but they remained similar in the number of passages, number of questions, form of questions, and time allocation. The pre-test and post-test were answered without the use of the concept mapping technique for either groups. The post-test was run to check whether using computer-assisted concept mapping had any significant effect on EFL learners' reading comprehension or not.

Results

To start with, the researchers had to analyze the data obtained from the administration of the language proficiency test. The descriptive statistics of the scores of the 60 students who took the test are presented in Table 1.

After administering the proficiency test, to make sure that these groups were homogeneous, the researchers conducted an independent samples t-test based on the total scores of the subjects in the two groups. In computing the t-test for small samples, the condition of homogeneity of variances must be met. Therefore, a Levene's test of homogeneity of variances was also run.

As it is shown in Table 2, the results of the Levene's test indicated that the two groups were homogeneous in terms of their variances (F=0.07, ρ=0.78). Moreover, the results of the independent t-test also indicated that there was no statistically significant difference between the means of the two groups (t=0.74, df=58, ρ=0.45>0.05).Therefore, it was concluded that the two groups were homogeneous in terms of their language proficiency.

Following the proficiency test, the pre-test was administered before the treatment. The descriptive statistics for the pre-test administration are presented in Table 3. Based on the information depicted on the table, the experimental group gained a mean of 42.37 and the control group's mean was 42.87.

Table 4 illustrates the results obtained from the comparison of the groups' mean values on the pre-test.

The comparison of the means revealed that there was no statistically significant difference between the mean scores of the experimental and control group on the pre-test (t=-0.37, df=58, ρ= 0.7>0.05). Therefore, the two groups were homogeneous in their reading knowledge and the researchers could confidently claim that with no significant difference in this aspect of the learners' knowledge at the outset of the study, any probable difference in their achievement at the end of the treatment could be attributed to the treatment.

The next step in this study was the administration of the post-test. Table 5 shows the descriptive statistics for the post-test scores of the two groups. As it is revealed in Table 5, the experimental group's mean turned out to be 46.97 and the control group's mean was 43.57.

Table 6 illustrates the results obtained from the comparison of the mean values of the two groups on the post-test.

The comparison of the mean values of the two groups on the post-test indicated that the difference between the means of the two groups was statistically significant (t= 2.87, df=58). Therefore, the researchers concluded that difference between sample means was large enough to be attributed to the different instructional methods provided by the researchers. In other words there was a significant difference between the two groups' mean scores for reading comprehension.

Discussion and Conclusion

The aim of this study was to check if using computer assisted concept mapping had any significant impact on the reading comprehension of Iranian EFL learners. Since at the outset of the study the participants were homogenized with respect to both general proficiency and their reading comprehension, the significant difference observed between the two groups in terms of their reading comprehension at the end of the treatment period could be logically attributed to the impact of computer assisted concept mapping as a new intervention strategy.The comparison of the mean values of the two groups on the post-test indicated that the difference between the means was statistically significant (t= 2.87, df=58). The experimental group gained a mean of 46.97 on the post-test which had a stark difference with the mean of the control group (M= 43.57). The noticeable difference between the means of the two groups can be attributed to the improvement of reading comprehension skill in the experimental group. Therefore, using computer assisted concept mapping strategy can be an ancillary means for improving reading comprehension of EFL learners.

The results of the study conform to the findings of Liu, Chen, and Chang (2009). They introduced a computer-assisted concept mapping learning strategy to the learners in an experimental class to improve their reading ability. Through two-way ANOVA analysis, it was cleared that the computer-assisted concept mapping learning strategy had far better reading advantages for low and high proficiency learners of English both.

The results of this study are also compatible with findings of Dyer (1985) who studied the application of concept mapping in reading stories. His study showed that the two experimental groups which had assistance with concept maps in learning achieved better scores than the control group on a comprehension test. The results of the study showed the performance of the students in this system might provide an alternative indicator for exploring students' mental processes in understanding a passage. Withthe help of thenew technology, the students' self- monitoring and independent learning can be developed. In the paradigm of constructivism, creation of student-centered learning environments and employment of multiple modes of instruction and assessment are encouraged to be done by the teachers (Brooks & Brooks, 1993; Tsai, 1998; 2000). Computer assisted concept maps can be a welcome change mode for extending independent reading.

One month after the treatment, the researchers observed that students could still remember the topics and the concepts of the readings which were presented during the treatment. Students used to refer back to the previously learned concepts and topics when they read new passages. The concepts in the readings used to reside in their long term memory and the students' habit of memorizing disappeared to some extent. It was observed that computer assisted concept mapping minimized the number of pupils who instead of comprehending the association between the concepts, tried to memorize information. This creats a learning puzzle which is in turn achieved through the application of visual displays. The building of this puzzle permits the student to connect information together by manipulating the pieces to structure a meaningful concept and not by memorizing. Therefore, meaningful learning can be reinforced with the help of computer assisted concept mapping technique.

During the administration of the research, the researchers noticed some students felt visibly tired after gleaning information from computer and they were rubbing their eyes after using computers. It seems a good suggestion for web programmers or program designers when they design the layout or the content of the program, and for teachers while designing lesson plans to consider the background color or the font size. If they design colorful pictures and appropriate font size and background colors, students will not have tired eyes.

It is anticipated that with the swift development in the field of communication and information technology, students will enjoy the learning of a new language and convert their negative attitudes towards attending language learning classes. Taking the aforementioned issues into consideration, the researchers hope that computer assisted concept mapping can be an ancillary means towards developing the reading skill of EFL students.

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