

Exploring the Effects of Concept Mapping on Undergraduate Students' EFL Reading Comprehension in China

Na Ta¹, Abu Bakar Razali¹, & Fazilah Razali¹

¹ Faculty of Educational Studies, Universiti Putra Malaysia (UPM), 43400 UPM Serdang Selangor, Malaysia

Correspondence: Abu Bakar Razali, Faculty of Educational Studies, Universiti Putra Malaysia (UPM), 43400 UPM Serdang Selangor, Malaysia.

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Abstract

Reading is a fundamental life-long learning tool to achieve personal and professional success, and it has been attached with great importance in China. However, despite the significance of reading comprehension, EFL undergraduate students in China face challenges when reading in English language. It is essential for both teachers and researchers to explore effective teaching techniques to teach reading. In this regard, concept mapping can serve as a specific form of teaching and learning technique for reading instruction. The present study employed a quasi-experiment to investigate the effects of concept mapping on the EFL reading comprehension of undergraduate students in China. The study spanned 32 instructional sessions, and the effects on knowledge retention were measured two weeks after the experiment. The participants included 135 second-year undergraduate students from three intact EFL classes at a university in China. The findings revealed that the use of concept mapping technique was effective in improving students' reading comprehension. Moreover, the combined use of concept mapping with conventional method was more effective than fully using concept mapping in promoting students' reading comprehension and knowledge retention. The study gives pedagogical and policy implications for teachers, syllabus designers, curriculum developers, and other stakeholders.

Keywords: concept mapping, reading comprehension, knowledge retention

1. Introduction

1.1 Background of the Study

Reading in English is an essential skill and a fundamental life-long learning tool for EFL learners who have fewer opportunities to communicate and gain knowledge in English to achieve personal and professional success. Teaching EFL reading comprehension has been considered as the focus of many studies in the field of teaching and learning a foreign language (Macaro, 2003). EFL reading and reading comprehension has also been regarded as highly important in China. Chinese EFL learners read for the purpose of academic advancement as well as career development (Brantmeier, Strube, & Yu, 2014). This emphasis on reading well is particularly noted for Chinese EFL learners at undergraduate level, who are required by *A Guide to College English Teaching (2020)* proposed by China's Higher Education Department of Ministry of Education, to achieve a high level of reading ability and master good listening, speaking, writing, and translation skills.

However, despite of the great importance of EFL reading comprehension, EFL readers generally face great challenges when reading in English language. According to McNamara (2007), EFL readers usually have no difficulty understanding each word in the article individually. However, when these words are combined into long sentences within a specific context, students often struggle to grasp the intended meaning. Shehu (2015) also stated that the biggest problem that students encountered in their EFL reading was their excessive focus on the meaning of every single word, which resulted in a lack of overall comprehension of the text. In other words, EFL learners tend to read articles word-by-word without connecting the ideas, leading to fragmented understanding of the intended meaning (Zarei & Alipour, 2020). As a consequence, they struggle to comprehend a text in a connected and holistic manner, often finding reading to be a challenging task (Cynthia & Narayana, 2019; Shehu, 2015). These issues are particularly prevalent in Chinese EFL classrooms, where teachers focus mostly on the linguistic aspects of reading texts and often require students to translate the texts from English to Chinese word by word during the reading process, which leads to students' rote learning or simply memorizing information (He, 2006), as well as fragmental understanding of the reading articles (Hu & Baumann, 2014).

Therefore, it is essential for both teachers and researchers to explore effective teaching techniques to help students organize scattered knowledge and construct meaningful knowledge while reading (Wang, 2019). In other words, EFL teachers need to adopt more effective teaching methods to meet the needs of EFL students (Ali & Razali, 2019). In fact, in China, *A Guide to College English Teaching (2020)* also requires teachers to "adopt task-based, cooperative, project-based, inquisitive, and other teaching methods and techniques to guide and help students improve their learning" (p. 33-34). This means that college English teachers in China should employ various teaching techniques in the process of teaching reading.

One of the more popular and effective teaching techniques in teaching reading for EFL learners that is being practiced across the world is the use of concept mapping. Concept mapping in reading refers to the construction of a graphical diagram to organize textual information and represent meaningful connections among the concepts presented in the text. There are three components that embody the basic features of concept maps, namely concepts, connecting lines, and linking words or phrases. Concepts are key words represented by appropriate nouns or phrases placed in boxes or circles, which are connected by connecting lines to represent meaningful connections. Concept mapping offers numerous benefits in reading instruction. A study revealed that students demonstrated higher comprehension scores after organizing concepts and indicating the nature of interrelations among them, suggesting that concept mapping was an effective instructional technique to activate students' prior knowledge (Gurlitt & Renkl, 2008). Other studies also indicated the improvement of students' reading comprehension by the use of concept mapping (Dolehanty, 2008), and students who learned with concept mapping technique exhibited significantly better summarization skills compared to those who used conventional summarization strategies (Hwang, Chen, Sung, & Lin, 2019).

Although some previous studies have demonstrated the positive impact of concept mapping on promoting EFL learners' reading ability (Liu, Chen, & Chang, 2010; Rassaei, 2019), controversy still exists due to conflicting findings from other studies (Andoko, Hayashi, Hirashima, & Asri, 2020; Furtado, Hirashima, & Hayashi, 2018) that suggest concept mapping to be time-consuming and effortful, potentially increasing learners' cognitive load and negatively affecting learning outcomes. Therefore, further research is necessary to determine how to mitigate these negative effects and use concept mapping more effectively in EFL reading classrooms.

In this regard, the researchers believe that concept mapping can serve as a specific form of teaching and learning technique for undergraduate students in China if used appropriately. Therefore, the current study is designed to examine the effects of concept mapping on EFL learners' reading comprehension by conducting experiments and comparing groups. One experimental group (i.e., experimental group 1) fully uses concept mapping, while the other experimental group (i.e., experimental group 2) combines concept mapping with conventional method. Additionally, a control group uses only the conventional method.

1.2 The Aim of the Study

The current study aims to investigate the effectiveness of the concept mapping technique in teaching EFL reading comprehension to undergraduate EFL students in the two conditions of fully using concept mapping and combining the use of concept mapping with conventional method of reading, as opposed to a control group that used the conventional English reading teaching method.

1.3 Research Questions

The following research questions were proposed in the study: (1) Is the use of concept mapping technique effective in improving Chinese EFL students' reading comprehension? (2) Is the use of concept mapping technique effective in enhancing Chinese EFL students' knowledge retention?

1.4 Research Hypotheses

Two null hypotheses were proposed for this study due to the controversies on effectiveness of using concept mapping in the teaching of EFL reading in previous studies.

H0-1: There is no significant difference in means of reading comprehension scores among the three groups of experimental group 1 (which used full concept mapping), experimental group 2 (which combined concept mapping and conventional method), and the control group (which used only conventional method) in the post-test.

H0-2: There is no significant difference in means of reading comprehension scores among the three groups of experimental group 1 (which used full concept mapping), experimental group 2 (which combined concept mapping and conventional method), and the control group (which used only conventional method) in the delayed post-test.

1.5 Reading Comprehension and Conventional Method of Teaching Reading

Comprehension is the ultimate goal of reading and there are various definitions of reading comprehension according to different experts. According to Ediger (2001), reading is a complex and interactive process involving "a text, a reader, and a social context within which the activity of reading takes place" (p. 154). By recognizing and getting the meaning of the words or sentences, readers use their knowledge of language structure to extract meaning from the printed text. Zimmerman, Gerson, Monroe, and Kearney (2007) further explained that reading comprehension involved a set of systematic and interrelated skills that helped students take relevant and important information from the text, make connections between this information and their prior knowledge, and accurately understand the meaning conveyed by the text.

The conventional method of teaching reading typically places a strong emphasis on linguistic knowledge of the target language (Sariah, Jamaluddin, & Setiadi, 2018) and it often involves prioritizing the understanding and memorization of vocabulary and grammatical rules, as well as relying on translation (He, 2006). The conventional way of teaching reading often requires students to answer questions while reading and write summaries or create outlines after reading (Curtis & Kruidenier, 2005). During this process, teachers invest considerable effort in explaining, questioning, and translating in the classroom. This conventional method of teaching reading is also still widely practiced in many educational institutions in China, including at the tertiary level.

In college English classes in China, the conventional English reading teaching method typically follows a lecture-based approach. The

process involves teachers explaining new words and providing background information on the text. Students are then instructed to have a skimming and scanning of the text to get the main idea and answer questions proposed by the teacher. This is followed by a detailed reading of the text, during which teachers explain linguistic aspects such as sentence structures. Students are asked to underline important ideas, explain the text using their own words, and translate the text from English to Chinese. Finally, the text is reviewed by summarizing important information or retelling (Guan, 2017; He, 2006).

1.6 Meaningful Learning Theory and Concept Mapping

Concept mapping technique was first developed by Novak in 1972 at Cornell University based on Ausubel's (1963) Meaningful Learning Theory, which was concerned with how individuals acquire knowledge or get information from textual presentations in school settings. According to Novak (1998), Ausubel described meaningful learning as "a process in which new information is related to an existing relevant aspect of an individual's knowledge structure" (p. 51). This relating of existing knowledge to new information enables students to acquire new meanings, memorize, and organize knowledge structure.

A concept map was defined by Novak (1981) as "the identification of concepts and the organization of those concepts into a hierarchical arrangement from the most general and most inclusive to the least general and most specific concept" (p. 3). There are three components that embody the basic features of concept maps, namely concepts, connecting lines, and linking words or phrases. Concepts are key words represented by appropriate nouns or phrases placed in boxes or circles, which are connected by connecting lines to represent meaningful connections. Connecting lines are lines with arrows, which can be unidirectional, bilateral, or in multiple directions to indicate the relationship among concepts and express meanings. Linking words or phrases are the words or phrases on the connecting lines that establish connections between two concepts and demonstrate the relations between them.

According to Dowhower (1999), concept mapping technique can be used at different stages of reading, including the preview stage before reading, the while-reading stage, and the after-reading stage. When used in the preview stage, concept mapping facilitates the activation of students' prior knowledge (Gurlitt & Renkl, 2008; Hattan & Alexander, 2018). During the while-reading stage, concept mapping has been proven to facilitate the development of students' schemata (Dixon & Bortolussi, 2013; Kintsch & Van Dijk, 1978), provide meaningful learning experience for integrating understanding of the text (Mintzes, Wandersee, & Novak, 2001), and develop students' critical thinking skills (Khonamri, Ahmadi, Pavlikova, & Petrikovicova, 2020; Sariah et al., 2018; Tseng, 2020). In the after-reading stage, concept mapping can be used to help students review the main concepts and the relationships between ideas presented in the text (Liu et al., 2010) and improve their summarization skills (Hwang et al., 2019). In addition, concept mapping technique not only improves and organizes learning but also enhances long-term memory retrieval (Farrand, Hussain, & Hennessey, 2002) and promotes knowledge retention (Cutrer, Castro, Roy, & Turner, 2011).

Several studies have investigated the use of concept mapping at different stages of reading. For example, Gurlitt and Renkl (2008) used concept mapping technique before the act of reading. In their study, concept maps were provided to high school and university students as a part of a pre-reading activity to activate their prior knowledge before digital reading of a text. One third of the students were asked to activate knowledge by organizing the given concepts and indicating their interrelations, one third of the students were simply asked to label provided lines in an otherwise complete map, and one third did not engage in mapping at any level. After activating knowledge, students read a digital text and then their scores in the post-assessment, consisting of short-answer and multiple-choice questions, were compared. The results showed that undergraduate students demonstrated higher comprehension scores after organizing the concepts and indicating the nature of interrelations of these concepts, proving that concept mapping was an effective instructional technique to activate prior knowledge.

Using concept mapping in the while-reading process, Dolehanty (2008) conducted a study in an English lab course at the secondary level by explicitly teaching concept mapping as a reading strategy. The data was collected from reading comprehension placement results, student self-evaluations, and daily observational journals. The maps created by students were stored in a virtual space, and the quality of the maps was assessed according to how much they reflected an understanding of what was read. The study indicated the improvement of students' reading comprehension by the use of concept mapping.

In China, Chang, Sung, and Chen (2002) conducted a study by asking students to do different activities after reading and compared the effectiveness of using these different types of concept maps with conventional method on reading comprehension. The study was conducted among 126 fifth grade elementary school students over a duration of 7 weeks. The students were randomly divided into the four groups of the scaffolding-map group, the map-correction group, the map-generated group, and the control group. In the control group, students were asked to read and make a summary from the article provided for the experiments. For the map-generated group, students were asked to generate concept maps by themselves, while for the map-correction group, students were provided with an expert-generated map with 40% of incorrect node interrelation and were asked to correct the node contents without fixing the map structure according to the reading material. Finally, summarization and comprehension tests were administered after the experiment. The results showed that the reading comprehension and summarization test results of students using map-correction type outperformed students with all the other teaching techniques, proving that using an expert-generated concept map could reduce teachers' workload and help avoid students' cognitive overload. The results of this study can be supported by similar research conducted by He (2006) and Hwang et al. (2019). He's (2006) study, conducted among Chinese senior high school students using qualitative and quantitative methods, demonstrated that teaching EFL reading with the aid of concept maps had a more positive effect on enhancing participants' reading proficiency and reading

habits compared to the conventional grammar-translation approach. Hwang et al. (2019) placed more emphasis on primary school students and conducted a study among 45 elementary school fifth-grade students using experimental design and found that students who learned with concept mapping technique showed significantly better summarization skills than those who learned with a conventional summarization strategy.

These previous studies provide evidence for the effectiveness of concept mapping for reading comprehension, typically adopting a pre-post-test experimental design with a control group and an experimental group. This current study differs from previous ones because it includes not only a pre-post-test but also a delayed post-test. More importantly, previous research has indicated that drawing concept maps can be challenging for learners and may lead to frustration and negative cognitive and affective outcomes (Chang et al., 2002). To address this issue, the current study proposes a possible solution by combining concept mapping with conventional method. Additionally, previous studies on concept mapping in China have mainly focused on primary, junior, and senior high school students, with undergraduate students being understudied. Therefore, in this current study, undergraduate students are the subjects of investigation.

2. Method

2.1 Research Participants

The present study adopted a quasi-experimental design, which included a pre-test, post-test, and delayed post-test with 135 second-year undergraduate students from three intact classes (each class consisting of 45 students) in a university in China. Intact classes were used to avoid disrupting the university's regular teaching plan and students' normal studies. However, the three classes were carefully selected to ensure the same baseline in terms of students' reading comprehension levels prior to the experiment. Specifically, the three classes were selected from a pool of classes with students who had similar admission scores and educational backgrounds. Subsequently, ten classes that met the criteria were randomly chosen to administer the pre-test for reading comprehension. From the four classes with similar pre-test scores, three classes were randomly recruited and assigned to the three conditions of two experimental groups and one control group. One experimental group (i.e., experimental group 1) was taught fully using concept mapping, where students were required to construct their own concept maps during the while-reading process. The other experimental group (i.e., experimental group 2) was taught combining concept mapping and conventional method, where students were taught using conventional method at the while-reading stage and only required to construct concept maps at the after-reading stage. Meanwhile, students in the control group received instruction using conventional method.

2.2 Research Instruments

Reading comprehension tests, selected and compiled from the reading part of CET-4 (College English Test-Band 4) test papers, were used to collect research data. Each reading comprehension test was made up of three sections: section A contained a passage with ten blanks to fill with words provided in a bank; section B involved matching information with the paragraph from which it derived; and section C comprised two reading comprehension passages followed by 10 multiple-choice questions. Participants were given 40 minutes to complete each reading comprehension test. The three sets of tests were piloted with a separate group of students to ensure the equal difficulty level ($t=0.65$, $p>0.8$) and high reliability ($\alpha=0.82$, 0.85 , 0.80 respectively).

2.3 Research Procedures

The study was carried out in the school year 2021-2022 (2) over 32 sessions (90 minutes for each session, 2 sessions a week) for one semester in EFL reading classrooms to ensure sufficient time for students to acquire the technique and minimize the "novelty" factor for the treatment groups that might influence the results. The whole research process went through three stages: the pre-experiment stage, treatment stage, and post-experiment stage.

In the pre-experiment stage, the two teachers who were in charge of the teaching of the two experimental classes were trained for one month before implementing the treatment. The training was conducted once a week with three hours for each time to guarantee the successful application of the technique in teaching EFL reading comprehension. A pre-test of reading comprehension was also administered to the three groups before the treatment to ensure the homogeneity of students prior to the experiment.

In the treatment stage, the three teachers implemented different treatments to the three groups over a duration of 32 sessions throughout the semester, which lasted 16 weeks. Classes were held twice a week, with each session lasting 90 minutes. For the two experimental groups, the concept mapping technique was introduced to students first, including an explanation of what a concept map was, why it was used in EFL reading classes, and how to construct concept maps while reading. There was also a control group that used only conventional method. In the two experimental groups, demonstrations were provided on how to construct a concept map, and students were given opportunities to practice and become familiar with the technique. Then, students in the two experimental classes were required to use concept mapping in their reading learning process. One group of students were taught fully using concept mapping (i.e., experimental group 1) and were required to construct their own maps during the while-reading stage, without any restrictions on content and format. The other experimental group, taught by using concept mapping and conventional method (i.e., experimental group 2), was asked to draw a concept map in the after-reading stage. For example, in unit 1, the teacher gave students in experimental group 1 the question "what aspects of DIY have you learned from the text?" and asked them to use any forms of concept maps with which they preferred to present their thoughts and ideas. Meanwhile, students in experimental group 2 did not need to construct their own concept maps during the while-reading stage; instead, they were taught by the conventional means such as explaining vocabulary, analyzing text

structure, and translating the passage from English to Chinese. But later in the after-reading stage, they were required to create a concept map based on the reading text to summarize or review what they had learned. The control group received regular reading classes with a conventional teaching method, where the same passages were used for instruction, but the teacher only used the reading exercise and activities suggested in the textbook.

In the post-experiment stage (the end of the experiment), a post-test of reading comprehension was conducted in the last week of the semester (week 16) for all three groups to measure the effectiveness of the treatments and compare them with the control group. Two weeks later, a delayed post-test was administered to the three groups to assess the retention of knowledge resulting from the concept mapping technique.

The data collected were analyzed using SPSS (version 2.60) with descriptive analysis, ANOVA analysis, and Post-Hoc Tukey HSD analysis.

3. Results

3.1 Results of Students' Reading Comprehension Pre-test and Post-test

Table 1. Descriptive statistics of the three intact groups on the reading pre-test

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
E1	45	64.00	15.98	2.38	59.20	68.80	33.00	98.00
E2	45	64.20	20.02	2.98	58.19	70.21	24.00	97.00
Control	45	64.27	13.01	1.94	60.36	68.18	42.00	97.00
Total	135	64.16	16.46	1.42	61.35	66.96	24.00	98.00

Table 1 indicates the descriptive statistics of the three groups on the reading pre-test. As shown in Table 1, the mean and standard deviation of E1 group (experimental group 1 that was taught fully using concept mapping) are 64.00 and 15.98, respectively. The same measures for E2 group (experimental group 2 that was taught combining concept mapping and conventional method) are 64.20 and 20.02, respectively. The control group (taught using conventional method) has a mean of 64.27 and a standard deviation of 13.01.

Although the three groups had similar mean scores in the pre-test, a One-way Analysis of Variance (ANOVA) was conducted to ensure the homogeneity of participants in the three groups regarding their reading comprehension before the treatment. In order to run ANOVA, the statistics had to meet the assumptions of normality and homogeneity of variances. Therefore, normality and homogeneity of variances were checked.

Table 2. Test of normality on the reading pre-test of the three intact groups

Groups	Shapiro-Wilk		
	Statistic	df	Sig.
E1	.971	45	.313
E2	.958	45	.101
Control	.971	45	.321

Table 2 shows that the p-values of Shapiro-Wilk test for the three groups are .313, .101, and .321, respectively, which are bigger than α .

Table 3. Test of homogeneity of variances on the reading pre-test

	Levene Statistic	df1	df2	Sig.
Based on Mean	2.713	2	132	.070

Table 3 shows that the quality of variances $F(2, 132)=2.713, p=.070$ on the pre-test, where the p-value is also bigger than α . Thus, the statistics met both assumptions of normality and homogeneity of variances, indicating that ANOVA could be applied.

Table 4. ANOVA results of the intact three groups on the reading pre-test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.733	2	.867	.003	.997
Within Groups	36324.000	132	275.182		
Total	36325.733	134			

Table 4 shows the results of ANOVA for participants' pre-test. According to Table 4, the difference in pre-test results among the three groups was not statistically significant, $F(2, 132)=.003, p=.997$. That is to say, there was no statistically significant difference among the means of the three groups prior to the treatment.

Table 5. Descriptive statistics of the three intact groups on the reading post-test

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
E1	45	80.20	10.73	1.60	76.98	83.42	59.00	98.00
E2	45	85.42	7.79	1.16	83.08	87.76	66.00	97.00
Control	45	74.11	10.04	1.50	71.10	77.13	56.00	94.00
Total	135	79.91	10.60	.91	78.11	81.72	56.00	98.00

At the end of the experiment, a post-test was carried out on participants in the three groups to measure their reading comprehension after the treatment. Table 5 shows the means of the three groups, which are 80.20, 85.42, and 74.11, respectively. The standard deviations are 10.73, 7.79 and 10.04, respectively. This indicates that the E2 group had a higher mean score than both the E1 and control groups, and the mean score of the E1 group was higher than that of the control group. To determine whether the observed differences were statistically significant or not, ANOVA was used.

Table 6. Test of normality on the reading post-test of the three intact groups

Groups	Shapiro-Wilk		
	Statistic	df	Sig.
E1	.967	45	.234
E2	.954	45	.071
Control	.951	45	.055

Table 6 presents the test of normality on the post-test, where the p-values (p= .234, .071, .055) are bigger than α .

Table 7. Test of homogeneity of variances on post-test of the three intact groups

	Levene Statistic	df1	df2	Sig.
Based on Mean	2.183	2	132	.117

Table 7 displays the homogeneity of variances, with $F(2, 132)=2.183$ and $p=.117$, indicating that ANOVA can be used.

Table 8. ANOVA results of the three intact groups on the reading post-test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2884.311	2	1442.156	15.649	.000
Within Groups	12164.622	132	92.156		
Total	15048.933	134			

Table 8 shows the results of ANOVA on participants' reading post-tests. It is evident that $F(2, 132)=15.649$ and $p=.000$, indicating that the first null hypothesis (H_0-1) of the study was rejected. Therefore, significant differences were found among the means of the three groups in the post-test at a significance level of .05. In other words, different teaching methods had varying effects on participants' reading comprehension by the end of the semester.

Table 9. Post-Hoc Tukey HSD test results for the three intact groups on the reading post-test

(I) groups	(J) groups	Mean (I-J)	Difference	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
E1	E2	-5.22222*		2.02382	.029	-10.0196	-.4249
	Control	6.08889*		2.02382	.009	1.2915	10.8862
E2	E1	5.22222*		2.02382	.029	.4249	10.0196
	Control	11.31111*		2.02382	.000	6.5138	16.1085
Control	E1	-6.08889*		2.02382	.009	-10.8862	-1.2915
	E2	-11.31111*		2.02382	.000	-16.1085	-6.5138

*. The mean difference is significant at the 0.05 level.

To determine the specific differences among the means of the three groups, a post-hoc Tukey HSD (Honestly Significant Difference) test was employed. The results of the comparisons are presented in Table 9, clearly showing that the mean scores of the three groups in the post-test were significantly different from one another. Specifically, both the E1 (i.e., experimental group 1 that was taught fully using concept mapping) and the E2 (i.e., experimental group 2 that was taught using concept mapping and conventional method) groups had significant better results compared to the control group (which was taught using conventional method) ($p=.009$ and $p=.000$, respectively). Additionally, there was a significant difference in the post-test results between the E1 and E2 groups in favor of the E2 group ($p=.029$). That is to say, participants who received concept mapping training gained significantly higher scores in the post-test, with the group combining concept mapping and conventional method showing the greatest improvement.

To provide a clearer understanding of the differences among the scores obtained by participants in the experimental and control groups, the effect size was calculated using eta squared ($\eta^2=.192$). The value of eta squared was bigger than .14, indicating a large effect size. Thus, 19.2% of the total variance in the dependent variable of reading comprehension ability was accounted for by the independent variable of teaching methods.

3.2 Result of Students' Reading Comprehension Delayed Post-test

The treatments concluded at the end of the semester. Two weeks later, a delayed post-test of reading comprehension was conducted to find out the retention effects of different teaching methods.

Table 10. Descriptive statistics of the three intact groups on the reading delayed post-test

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
E1	45	74.51	11.90	1.77	70.94	78.09	50.00	97.00
E2	45	78.91	10.07	1.50	75.89	81.94	59.00	96.00
Control	45	71.18	9.87	1.47	68.21	74.14	51.00	89.00
Total	135	74.87	11.04	.95	72.99	76.75	50.00	97.00

Table 10 shows the descriptive statistics of the three groups on the delayed post-test. According to Table 10, the mean scores for the three groups in the delayed post-test were 74.51, 78.91, and 71.18, with standard deviations of 11.90, 10.07, and 9.87, respectively. The highest mean score was observed in the E2 group, followed by the E1 group and the control group. ANOVA was employed to determine the significance of the differences.

Table 11. Test of normality on the reading delayed post-test of the three intact groups

Groups	Shapiro-Wilk		
	Statistic	df	Sig.
E1	.974	45	.399
E2	.955	45	.082
Control	.952	45	.061

Table 11 displays the test of normality on the delayed post-test, indicating that the data follow a normal distribution, as the p-values of Shapiro-Wilk are .399, .082, and .061, respectively.

Table 12. Test of homogeneity of variance on delayed post-test of the three intact groups

Levene Statistic	df1	df2	Sig.
1.087	2	132	.340

Table 12 is the result of the homogeneity of variances, with $F(2, 132) = 1.087$ and $p = .340 (> .05)$. Therefore, the statistics fulfill the assumption of normality and homogeneity of variance, allowing for the application of ANOVA.

Table 13. ANOVA results of the three intact groups on the reading delayed post-test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1354.133	2	677.067	5.966	.003
Within Groups	14981.467	132	113.496		
Total	16335.600	134			

Table 13 provides the results of the ANOVA analysis on the delayed post-test scores. It is observed that $F(2, 132) = 5.966$ and $p = .003 (< .05)$, indicating the rejection of the second null hypotheses (H_0-2) of the study. Consequently, significant differences exist among the mean scores of the three groups in the delayed post-test at a significance level of .05. Therefore, different teaching methods exhibit varying retention effects on participants' reading comprehension.

Table 14. Post-Hoc Tukey HSD test results for the three intact groups on the reading delayed post-test

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
E1	E2	-4.40000	2.24594	.127	-9.7239	.9239
	Control	3.33333	2.24594	.302	-1.9906	8.6572
E2	E1	4.40000	2.24594	.127	-.9239	9.7239
	Control	7.73333*	2.24594	.002	2.4094	13.0572
Control	E1	-3.33333	2.24594	.302	-8.6572	1.9906
	E2	-7.73333*	2.24594	.002	-13.0572	-2.4094

*. The mean difference is significant at the 0.05 level.

To find out where the differences lay, a post-hoc Tukey HSD test was employed. Table 14 shows the results of the comparisons. According to Table 14, the mean score of the E2 group was significantly different from the mean score of the control group ($p = .002$). However, no significant difference was observed between the E1 and E2 groups ($p = .127$) or between the E1 and the control groups ($p = .302$). Therefore, two weeks after completing the experiment, students in the E2 group demonstrated significantly better knowledge retention compared to the control group. But there was no significant difference in knowledge retention between the E1 group and the control group.

The effect size, calculated as $\eta^2 = .083$, indicated a medium effect size. That is to say, 8.3% of the differences in reading comprehension scores between the E2 group and the control group could be explained by the use of concept mapping technique.

4. Discussion

4.1 Effectiveness of Concept Mapping Technique on EFL Reading Comprehension

The first research question aimed to investigate the effectiveness of using concept mapping technique in improving Chinese EFL students' reading comprehension. To this end, the scores of the three intact groups in the pre- and post-reading comprehension tests were compared. It was found that compared to the conventional method, the concept mapping technique was more effective in improving EFL learners' reading comprehension, as both experimental groups significantly outperformed the control group. This finding corroborated the results of

numerous previous studies that have indicated the effectiveness of concept mapping in enhancing learners' reading comprehension. For example, Andoko et al. (2020) reported that students who used the concept mapping technique had better performance in English reading compared to those who employed the conventional method. Likewise, Rassaei (2019) compared the pre-test and post-test reading results of students using concept maps and conventional method and found that students' reading comprehension improved a lot after using concept mapping technique. In line with this finding, Morfidi, Mikropoulos, and Rogdaki (2018) also emphasized the superiority of concept mapping over a conventional lecture-based approach in teaching reading. This finding can be explained by the Meaningful Learning Theory, which suggests that the use of concept mapping encourages meaningful learning by activating students' prior knowledge and promoting the selection of meaningful learning. By using concept mapping, students were prompted to represent information or knowledge in meaningful ways rather than relying on rote memorization and passive learning (Novak, 2002).

Additionally, significant differences were found between the full concept mapping group (i.e., experimental group 1) and the group that combined concept mapping with conventional method (i.e., experimental group 2). To the best of the researcher's knowledge, there was no studies in previous literature that compared the effectiveness of using full concept mapping and combining concept mapping with conventional method in relation to reading comprehension. Nevertheless, the superiority of combining concept mapping with the conventional method can be attributed to the fact that in full concept mapping, students faced greater challenges, as they had to rely more on themselves to explore the use of key words and linking words and make connections between concepts, which could be difficult and create pressure for them. This can be corroborated by Chang et al. (2002), who claimed that constructing concept maps alone might be difficult and frustrating for learners and resulted in negative cognitive and affective outcomes. Chang et al. (2001) also argued that the task of drawing a concept map could be time-consuming and effortful, often leading to increased cognitive load and potentially negative effects on learning outcomes. On the contrary, in the group that combining concept mapping with the conventional method, the teacher dedicated a significant amount of time to providing instructions on the explanation and usage of vocabulary and phrases. In the after-reading stage, students were required to use these words and phrases as their key concepts and linking words to construct concept maps. Moreover, the analysis of text structure and contents was also done under the guidance of the teacher, who provided clues for reorganizing information. As a result, students' cognitive load was greatly relieved in the group that combined concept mapping with the conventional reading method, which enabled them to use concept maps more effectively to promote the learning of reading comprehension.

4.2 Retention Effects of Concept Mapping Technique on EFL Reading Comprehension

The second research question aimed to explore the effectiveness of using concept mapping technique in enhancing Chinese EFL students' knowledge retention. From the results of the delayed post-test of reading comprehension, it was found that by combining concept mapping technique with the conventional method, the E2 group showed significant differences from the other two groups. However, no significant difference was found between the group using full concept mapping method and the group using the conventional method. This finding is harmonized with Davies's (2011) claim that concept mapping may not always assist in memorability due to its complexity. However, it is not consistent with the results of some previous studies (Cutrer et al., 2011; Liu et al., 2010) that demonstrated the retention effects of concept mapping compared to the conventional method. According to Zwaal and Otting (2012), concept mapping can enhance information retention because its use could simplify the associations between concepts and thus facilitate long-term memory retrieval. Ideally, concept maps allow students to organize information in a visual way, making it easier for brain to process and retain information. Moreover, concept mapping encourages students to make connections between different concepts, which helps them form a deeper understanding of the relationship between the concepts and remember the knowledge in the long term. It is obvious that students in combining concept mapping with conventional method group were able to use concept maps to organize knowledge in a structured way and make the connections between concepts simple enough for easy storage and retrieval. However, for students who were taught fully using concept mapping, they spent more time exploring and constructing concept maps without as much guidance from the teacher on vocabulary and phrase usage, as well as text structure analysis. As a result, they were likely to meet problems in the spatial organization of concept maps (Veronese, Richards, Pernar, Sullivan, & Schwartzstein, 2013) and encounter difficulties in identifying concepts and establishing connections (Machado & Carvalho, 2020). Consequently, students taught by fully using concept mapping did not achieve the same knowledge retention effects as students in combining concept mapping with conventional method group. This difference might be bridged by getting more assistance from the teacher in terms of forming visual and structural frameworks and establishing meaningful connections between concepts.

5. Conclusion

5.1 Summary of the Study

This study aimed to investigate the effectiveness of concept mapping technique in teaching EFL reading comprehension among undergraduates in China. Based on the research questions, it can be concluded that concept mapping is an effective technique for improving Chinese EFL learners' reading comprehension, especially when concept mapping is used in combination with the conventional method. This combination can better facilitate both reading comprehension and knowledge retention.

5.2 Implications

The study has important pedagogical and policy implications for teachers, syllabus designers, curriculum developers, and other stakeholders. The researchers recommend that teachers, schools, and institutions incorporate the optimal use of concept mapping technique with conventional teaching methods for EFL reading comprehension. The findings also suggest that syllabus designers and curriculum

developers include concept mapping activities in the before, during, and after reading processes and provide teachers training programs on the effective use of such technique.

5.3 Limitations and Recommendations

However, it is important to note that since the study was conducted in Chinese EFL context with the participants of undergraduate students, the findings may not be generalizable to students of different levels or in different regions. Therefore, future research should replicate the study to test the effectiveness of concept mapping technique in teaching EFL reading among different participant groups.

Besides, it should be acknowledged that the fluent and flexible use of concept mapping may require significant time and practice (Carstens, Masenge, Immelman, & Smith, 2020). In this study, the experiment had to conclude after the post-test due to the end of the semester. Therefore, it is recommended to conduct a longitudinal study with a longer duration, such as two semesters, to investigate if different results can be obtained, particularly when comparing full concept mapping with combining concept mapping with the conventional method.

References

- Ali, A. M., & Razali, A. B. (2019). A review of studies on cognitive and metacognitive reading strategies in teaching reading comprehension for ESL/EFL learners. *English Language Teaching, 12*(6), 94-111. <https://doi.org/10.5539/elt.v12n6p94>
- Andoko, B. S., Hayashi, Y., Hirashima, T., & Asri, A. N. (2020). Improving English reading for EFL readers with reviewing kit-build concept map. *Research and Practice in Technology Enhanced Learning, 15*(7). <https://doi.org/10.1186/s41039-020-00126-8>
- Ausubel D. P. (1963). Cognitive structure and the facilitation of meaningful verbal learning. *Journal of teacher education, 14*(2), 217-222. <https://doi.org/10.1177/002248716301400220>
- Brantmeier, C., Strube, M., & Yu, X. (2014). Scoring recalls for L2 readers of English in China: Pausal or idea units. *Reading in a foreign language, 26*(1), 114-130. Retrieved from <https://nflrc.hawaii.edu/rfl>
- Carstens, A., Masenge, A., Immelman, S., & Smith, S. (2020). Concept mapping as a strategy to scaffold concept literacy in accounting for extended programmes. *South African Journal of Higher Education, 34*(1), 116-136. <https://doi.org/10.20853/34-1-3075>
- Chang K. E., Sung Y. T., & Chen I. D. (2002). The effect of concept mapping to enhance text comprehension and summarization. *The Journal of Experimental Education, 71*(1), 5-23. <https://doi.org/10.1080/00220970209602054>
- Chang, K. E., Sung, Y. T., & Chen, S. F. (2001). Learning through computer-based concept mapping with scaffolding aid. *Journal of computer assisted learning, 17*(1), 21-33. <https://doi.org/10.1111/j.1365-2729.2001.00156.x>
- China's Higher Education Department of Ministry of Education. (2020). *A guide to college English teaching*, Higher Education Press.
- Curtis, M. E., & Kruidenier, J. R. (2005). *A summary of scientifically based research principles: Teaching adults to read*. National Institute for Literacy.
- Cutrer, W. B., Castro, D., Roy, K. M., & Turner, T. L. (2011). Use of an expert concept map as an advance organizer to improve understanding of respiratory failure. *Medical Teacher, 33*(12), 1018-1026. <https://doi.org/10.3109/0142159X.2010.531159>
- Cynthia, V. L., & Narayana, T. (2019). A study of the issues and the factors on reading efficiency in ESL at undergraduate level. *International Journal of English, 9*(2), 39-48. <https://doi.org/10.24247/ijelapr20197>
- Davies, M. (2011). Concept mapping, mind mapping and argument mapping: What are the differences and do they matter? *Higher Education, 62*(3), 279-301. <https://doi.org/10.1007/s10734-010-9387-6>
- Dixon, P., & Bortolussi, M. (2013). Construction, integration, and mind wandering in reading. *Canadian Journal of Experimental Psychology, 67*(1), 1. <https://doi.org/10.1037/a0031234>
- Dolehanty, C. (2008). Concept mapping and reading comprehension. Retrieved from: <http://www.doc-txt.com/Concept-Map-Maker.pdf>.
- Dowhower, S. L. (1999). Supporting a strategic stance in the classroom: A comprehension framework for helping teachers help students to be strategic. *The Reading Teacher, 52*(7), 672-688. <https://www.jstor.org/stable/20204670>
- Ediger, A. (2001). Teaching children literacy skills in a second language. In Celce-Murcia, M. (3rd ed.), *Teaching English as a second or foreign language* (p. 154). HEINLE & HEINLE.
- Farrand, P., Hussain, F., & Hennessy, E. (2002). The efficacy of the 'mind map' study technique. *Medical education, 36*(5), 426-431. <https://doi.org/10.1046/j.1365-2923.2002.01205.x>
- Furtado, P. G. F., Hirashima, T., & Hayashi, Y. (2018). Reducing cognitive load during closed concept map construction and consequences on reading comprehension and retention. *IEEE Transactions on Learning Technologies, 11*(2), 402-412. <https://doi.org/10.1109/TLT.2018.2861744>
- Guan, T. J. (2017). *Effects of computer-assisted concept mapping strategy on non-English learners' English reading comprehension - a study based on sophomores' ESP reading course*. PhD Thesis. Xinan University, China.
- Gurlitt, J., & Renkl, A. (2008). Are high-coherent concept maps better for prior knowledge activation? Differential effects of concept mapping tasks on high school vs. university students. *Journal of Computer Assisted Learning, 24*(5), 407-419.

<https://doi.org/10.1111/j.1365-2729.2008.00277.x>

- Hattan, C., & Alexander, P. (2018). Scaffolding reading comprehension for competent readers. *Literacy Research: Theory, Method, and Practice*, 67(1), 296-309. <https://doi.org/10.1177/2381336918786>
- He, Y. (2006). *A study on the application of concept maps to EFL reading teaching in high school*. PhD Thesis. Xibei Normal University, China.
- Hu, R., & Baumann, J. (2014). English reading instruction in China: Chinese teachers' perspectives and comments. *The Reading Matrix*, 14, 26-60.
- Hwang, G. J., Chen, M. R. A., Sung, H. Y., & Lin, M. H. (2019). Effects of integrating a concept mapping-based summarization strategy into flipped learning on students' reading performances and perceptions in Chinese courses. *British Journal of Educational Technology*, 50(5), 2703-2719. <https://doi.org/10.1111/bjet.12708>
- Khonamri, F., Ahmadi, F., Pavlikova, M., & Petrikovicova, L. (2020). The effect of awareness raising and explicit collocation instruction on writing fluency of EFL learners. *European Journal of Contemporary Education*, 9(4), 786-806. <https://doi.org/10.13187/ejced.2020.4.786>
- Kintsch, W., & Van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological review*, 85(5), 363. <https://doi.org/10.1037/0033-295X.85.5.363>
- Liu, P. L., Chen, C. J., & Chang Y. J. (2010). Effects of computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension. *Computer & Education*, 54(2), 436-445. <https://doi.org/10.1016/j.compedu.2009.08.027>
- Macaro, E. (2003). Second language teachers as second language classroom researchers. *Language Learning Journal*, 27(1), 43-51. <https://doi.org/10.1080/09571730385200071>
- Machado, C. T., & Carvalho, A. A. (2020). Concept mapping: Benefits and challenges in higher education. *The journal of Continuing Higher Education*, 68(1), 38-53. <https://doi.org/10.1080/07377363.2020.1712579>
- McNamara, D. S. (2007). *Reading comprehension strategies: Theories, interventions, and technologies*. Lawrence Erlbaum Associates Publishers. <https://doi.org/10.4324/9780203810033>
- Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (2001). Assessing understanding in biology. *Journal of biological education*, 35(3), 118-124. <https://doi.org/10.1080/00219266.2001.9655759>
- Morfidi, E., Mikropoulos, A., & Rogdaki, A. (2018). Using concept mapping to improve poor readers' understanding of expository text. *Educ Inf Technol*, 23, 271-286. <https://doi.org/10.1007/s10639-017-9600-7>
- Novak, J. D. (1981). Applying learning psychology and philosophy of science to biology teaching. *The American Biology Teacher*, 43(1), 12-42. <https://doi.org/10.2307/4447108>
- Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations*. Lawrence Erlbaum Associates, Inc.
- Novak, J. D. (2002). Meaningful learning: The essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. *Science Education*, 86(4), 548-571. <https://doi.org/10.1002/sci.10032>
- Rassaei, E. (2019). Effects of two forms of concept mapping on L2 reading comprehension and strategy awareness. *Applied Linguistics Review*, 10(2), 93-116. <https://doi.org/10.1515/applirev-2017-0006>
- Sariah, S., Jamaluddin, J., & Setiadi, D. (2018). The learning tools based on the REMAP TMPS model (reading concept map timed pair share) and the effectiveness of students critical thinking skills. *Jurnal Penelitian Pendidikan IPA(JPPIPA)*, 4(2), 34-37. <https://doi.org/10.29303/jppipa.v4i2.123>
- Shehu, I. (2015). Reading comprehension problems encountered by foreign language students, case study: Albania, Croatia. *Academic Journal of Interdisciplinary Studies*, 4(1), 91. <https://doi.org/10.5901/mjss.2015.v4n1s1p91>
- Tseng, S. S. (2020). Using concept mapping activities to enhance students' critical thinking skills at a high school in Taiwan. *The Asia-Pacific Education Researcher*, 29(3), 249-256. <https://doi.org/10.1007/s40299-019-00474-0>
- Veronese, C., Richards, J. B., Pernar, L., Sullivan, A. M., & Schwartzstein, R. M. (2013). A randomized pilot study of the use of concept maps to enhance problem-based learning among first-year medical students. *Medical Teacher*, 35(9), e1478-e1484. <https://doi.org/10.3109/0142159X.2013.785628>
- Wang, S. H. (2019). Instruction design and strategy of concept mapping. *5th International Conference on Economics, Management, Law and Education*, 1195-1198. <https://doi.org/10.2991/aebmr.k.191225.236>
- Zarei, A. A., & Alipour, H. (2020). Shadowing and scaffolding techniques affecting L2 reading comprehension. *Applied Research on English Language*, 9(1), 53-74. <https://doi.org/10.22108/are.2019.117030.1462>
- Zimmerman, C., Gerson, S., Monroe, A., & Kearney, A. (2007). Physics is harder than psychology (or is it?): Developmental differences in

calibration of domain-specific texts. *Proceedings of the Annual Cognitive Science Society*, 29(29), 1683-1688.

<https://escholarship.org/uc/item/3tm3n98n>

Zwaal, W., & Otting, H. (2012). The impact of concept mapping on the process of problem-based learning. *Interdisciplinary Journal of problem-based learning*, 6(1), 104-128. <https://doi.org/10.7771/1541-5015.1314>

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