The Effect of Teaching through Three Types of Mind Maps (Bubble, Double-Bubble, and Multi-Flow) on the Comprehension and Production of English Collocations

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Article info	**Abstract**
	Given the importance of learning collocations, this study investigated the effectiveness of three types of mind maps, namely, bubble, double-bubble and multi-flow maps, on the comprehension and production of collocations. The participants were 120 upper-intermediate level male learners of English at Qalam institute in Tehran, who ranged from 15 to 18 years of age. This study used convenience sampling based on availability. A pretest was used to ensure the participants' unfamiliarity with the selected items. The participants belonged to four classes, each class being assigned to one treatment condition (one control and three experimental groups). All the groups had 12 treatment sessions, and in each session, eight collocations were introduced to the participants. After the treatment, two posttests of comprehension and production were given to all the participants, and the collected data were analyzed using two one-way analysis of variance (ANOVA) procedures. In both comprehension and production tests, the bubble and double-bubble map groups performed significantly better than the control group. Although there was a meaningful difference between the multi-flow map and the control group in the comprehension of collocations, there was no meaningful difference in the production of collocations. These results can have important implications for language teachers, curriculum designers, and educational policy makers.

Keywords: Bubble map, Collocations, Double-Bubble, Multi-flow, Mind mapping |

1. Introduction

It is commonly known that the building block of any language is its vocabulary (Naserpour & Zarei, 2021a). The common belief in learning a second language is that knowing many words is the most important aspect of being able to communicate effectively (Laufer, 2003). Single words like verbs and nouns as well as word groups like idioms and collocations make up vocabulary (Naserpour & Zarei, 2021b). According to Lewis (2000), collocation includes a set of words that are commonly used together. Shin and Nation (2008) noted that using collocations correctly can help learners become fluent in a language and use it in a natural way. Having a good understanding of how words go together is important for using those words effectively in speaking and writing. Zarei et al. (2016) found that when language learners are better at using collocations, they have fewer pauses while speaking. Therefore, both comprehension and production of collocations are essential in language proficiency and communication, which is the learners' ultimate goal (Zohrabi & Bimesl, 2022).

According to Laufer (2011), second language learners struggle with using word combinations, regardless of how long they have been studying the language, their first language, the type of activity they are doing, and how well they know individual words. As Suleiman (2022) acknowledges, deficient knowledge of collocations causes strange and incomprehensible language production. Therefore, misusing collocations results in miscommunication, or a breakdown in communication. People who are learning a second language may not know many collocations (Nguyen & Webb, 2017; Vu & Peters, 2021), and it may take longer for these learners to learn collocations compared to individual words (e.g., Peters, 2014). Therefore, any study that can help reduce learners' problems assumes significance.

Researchers have attempted to study how to facilitate the learning of these word combinations because of their value for both theoretical and pedagogical reasons (Yamagata et al., 2023). As a result, several techniques have been suggested that might boost the learning of collocations. One of these techniques is mind mapping, which is organizing thoughts and ideas by making a picture to show them in a visual and easy-to-understand way (Heidari & Karimi, 2015). The picture is mainly about one main idea that is put in the middle, and some words or ideas that are related to that concept are linked together (Rabeka, 2014). The use of mind maps has been regarded as a useful instructional instrument by many specialists (Zarei & Keysan, 2016). There are many types of mind maps in various categories, especially in education. According to Okada et al. (2014), there are eight types of mapping such as bridge map, double-bubble map, brace map, multi-flow map, circle map, tree map, flow map and bubble map. According to Zarei and Keysan (2016), mind mapping has considerable effects on vocabulary learning. Considering the

importance of mind mapping in teaching vocabulary, particularly collocations, the present researchers investigated the comparative effectiveness of bubble, double-bubble, and multi-flow maps on the receptive and productive knowledge of English collocations.

Several reasons motivated the present researchers to carry out this study. The first one is encouraging teachers to use modern instruments for teaching. Instead of using time-consuming and expensive ways for teaching vocabulary, teachers can use this method, which has been suggested by many researchers. The second reason is to determine which type of mind maps has the most beneficial effect. Determining the most effective type of mind maps can increase the awareness of teachers to apply them. Therefore, this study aimed to answer two research questions:

1. Are different types of mind maps (bubble, double-bubble, and multi-flow) equally effective on the comprehension of English collocations?
2. Are different types of mind maps equally effective on the production of English collocations?

2. Literature Review

2.1. Theoretical Background

2.1.1. Mind Maps

Mind mapping is a technique that involves the use of diagrams to visually present ideas. The central focus of the diagram is a main concept to which various related ideas, words, or phrases can be connected (Rabeka, 2014). It is an effective way to categorize complex ideas into more specific, easy-to-understand concepts which can be memorized better by learners (Buzan, 2000). According to Rabeka (2014), mind mapping helps learners to retain words. As Rabeka suggested, instruction through mind mapping is effective as it motivates learners to effortlessly utilize words. Furthermore, Betancur and King (2014) contend that mind maps offer students the opportunity to align and expand their cognitive capacities. Alignment activities aid in the development of various intelligences, while expansion exercises stimulate less developed intelligences through the integration of creative tasks involving the use of colors and shapes to establish connections. Consequently, as mind maps are of various kinds including graphical images and presentations, color coding, alphabetical mnemonics, and forms, they facilitate the creation of associations, foster the establishment of connections between concepts taught in class, and aid their retention for future reference.

Numerous researchers have highlighted that utilizing mind-mapping techniques in classrooms is highly advantageous for language students, improving their speaking (Rachmawati et al., 2020), reading (Malekzadeh & Bayat, 2015), writing skills (Wette, 2017), vocabulary knowledge (Yunus &

Chien, 2016), and reducing their anxiety (Yen, 2010). As Bukhari (2016) stated, language teachers should make their students familiar with what mind maps are and how they work and meanwhile encourage them to use their creativity to construct their own mind maps for independent learning. Regarding second language writing, for example, using color coding, arrows, lines, and symbols to make mind maps can make the writing process thought-provoking while suiting the learning style of each language learner. By so doing, thoughts and topics can be engendered with a robust connection to the central topic and in hierarchical or radial structures which can exert significant lasting effects on language learners' minds and retention (Karim & Mustapha, 2020).

Several studies have focused on how language learners learn and understand collocations, as well as how mind mapping can impact their ability to learn and retain words (e.g., Feng et al., 2023; Heidari & Karimi, 2015) or how mind mapping can enhance their reading comprehension and writing ability (e.g., Machida & Dalsky, 2014). However, there are very few studies, if any, which have investigated how mind mapping can assist language learners to learn collocations.

2.1.2. Collocations

Understanding vocabulary encompasses more than mere comprehension of a word's meaning in isolation. It is necessary for learners to possess familiarity with how words interact with one another. This knowledge is known as collocational knowledge (Rahimi & Momeni, 2012). Lei and Liu (2018) assert that collocations are a pivotal component of vocabulary. According to O'Dell and McCarthy (2008), collocations are a type of lexical bundle which are used together more frequently than expected by chance and act like a grammatical union of words. Therefore, it can be argued that collocations are a combination of words of different lexical categories (e.g., verbs, nouns, adjectives, and prepositions) that are used together in the natural flow of communication (Poulsen, 2022). In an initial effort to classify English collocations systematically, Benson et al. (1986) divided collocations into grammatical and lexical. According to this distinction, grammatical collocations comprise 19 types of structures in total with a content word as the core word and one function word, whereas lexical collocations are made up of only content words with no function words attached. In this study, researchers worked on verb-noun collocations (e. g., *make a call*).

Research has shown that learning collocations is an indispensable part of learning a new language, so focusing on teaching collocations in language classrooms has many advantages for second language learners (Arifani, 2019; Attar & Alami, 2013; Fanaee, 2014). Specifically, collocation instruction is seen to be more significant for foreign language learning contexts in which

language learners are less involved with the natural use of language outside the classroom; therefore, they have to learn more natural aspects of the target language in their instructional syllabus in the classroom (Jeensuk & Sukying, 2021). Previous studies have shown that a large majority of learners have reported serious issues learning collocations, comprehending them in natural speech, and producing them (e.g., Alsulayyi, 2015; Boers & Webb, 2018; Dokchandra, 2019; Mehmonova, 2022). Accordingly, Wongkhan and Thinthong (2021) maintained that teaching collocations should be an integral part of all EFL classrooms because the knowledge of collocations causes professional language performance.

Teaching collocations is deemed highly significant and beneficial in English for two main reasons (Zarei et al., 2016). Firstly, 90% of a native speaker's speech is comprised of merely 2,000 words, equivalent to the vocabulary knowledge of an intermediate level learner. What distinguishes an intermediate level learner from a native speaker is not acquaintance with those 2000 words but the ability to combine them effectively. Therefore, the most effective approach to elevate learners to the level of a native speaker is by teaching them how to combine already familiar words. Secondly, the way in which a word collocates can clarify its meaning. As Altuwairesh (2016) argues, collocations and chunks bridge the gap between vocabulary and grammar, acting as essential components that facilitate language use.

According to Dokchandra (2019), whereas advanced EFL learners have a wide range of vocabulary and grammatical knowledge rules, they may be unable to produce utterances as naturally as native speakers due to poor collocational knowledge. Hence, they are forced to produce long utterances to convey their message while they can produce the same message with less effort in fewer words. On the other hand, given the significance of collocation teaching in language classes, Schmitt (2000) stated that there are two challenges language teachers can face while teaching collocations: the huge number of colocations in the target language, and the lack of a robust method of instruction. Furthermore, Durrant and Schmitt (2010) emphasized that language instructors should improve learners' knowledge of collocations by drawing their attention to the combinations of words in listening and reading. Nevertheless, collocations are regarded as challenging, but vital for language learning, and learners are expected to master them as much as they can to perform more efficiently in their speaking and writing (Ghazali, 2015). Particularly, in the Iranian EFL context, it is reported that colocations are mostly underestimated by teachers, or material developers, which results in weaker language performance in productive skills (e.g., Fanaee, 2014; Rad & Saniei, 2016; Vahabian et al., 2018).

2.2. Empirical Background
2.2.1. Mind Maps

Among the different language skills and subskills that have been studied to investigate the effect of mind maps, vocabulary and writing are the most prevalent ones. Zarei and Keysan (2016) reported the efficiency of mind maps in EFL vocabulary learning. They used a series of concept maps, mind maps, and mnemonics for this purpose and reported that employing mind maps and other visual graphics significantly improved EFL learners' comprehension and production of vocabulary. More recently, Rodriguez (2022) studied how mind maps can help EFL learners to learn collocations. He used lexico-semantic mind maps as his main instructional instrument. The results of his study showed that lexico-semantic mind maps are the most effective type of mind maps to teach English collocations. Such findings were also corroborated by Feng et al. (2023), who observed that using mind-map vocabulary coordinators significantly improved vocabulary learning.

Feng et al. (2023) explored the effect of mind-mapping techniques on vocabulary retention, learning motivation, and willingness to communicate (WTC). A total of 98 ESL learners were selected and assigned to a control group (CG) consisting of 30 participants and an experimental group (EG) with 30 participants. Initially, all the participants sat pretests of WTC, motivation, and vocabulary. Then, the two groups were provided with distinct instructions; the EG received the mind-mapping instruction while the CG received conventional instruction. Following a 23-session intervention, the same tests were administered as posttests. The findings revealed that the EG demonstrated superior performance compared to the CG on all the tests.

The skill of writing has also attracted attention in the past decades. For instance, focusing on EFL learners' perceptions in a qualitative study, Karim and Mustapha (2020) reported enhanced positive attitudes and motivations among learners while using mind maps in their writing classes. Later on, Yue (2023) focused on writing and reading skills and examined how mind maps can facilitate language learners' performance in the Chinese EFL context. The results of her study revealed that mind maps help learners improve both skills.

The use of mind-mapping techniques in other language skills has also attracted the attention of second language researchers. To give an example, Al-Jarf (2021) examined how using mind-mapping software to create relevant lexical and topical mind maps by EFL students can improve their reading comprehension. In particular, focus was on how mind maps could help learners understand the main idea of reading passages and paragraph organization. His results showed that the software could facilitate the process of mind-map construction for both teachers and learners. Moreover, he observed that mind-mapping techniques improved the way learners detected the main idea of passages and the relevant conceptual organizational patterns of passages. As

for the skill of speaking, Ningsih and Ayu (2023) examined the effect of mind maps on EFL learners' speaking in Malaysia. They found that using mind maps not only improved learners' motivation and interest but also their speaking ability.

Seyyedi et al. (2023) investigated the impact of utilizing pictorial concept mapping on retaining collocations. A total of 59 intermediate-level learners were randomly divided into three groups: individual concept mapping, collaborative concept mapping, and translation. Each group received identical materials for an equal length of time. The two concept-mapping groups utilized pictorial techniques, whereas the third group learned collocations through translation. After a 10-week period, the collaborative concept mapping group outperformed the other groups on immediate and delayed posttests. The present researchers investigated the effects of three types of mind maps on comprehension and production of collocations.

2.2.2. Collocations

Different aspects of collocations and their learning have been investigated. In the Iranian EFL context, Zarei et al. (2016) investigated the effect of visual, semantic, and input flooding enhancements on the learning of lexical collocations. Different input enhancement techniques were given to the learners via various reading passages in which collocations were highlighted. In the end, EFL learners' production and comprehension of lexical collocations were checked in speaking and listening activities. Their results showed that all the three types of input enhancement were significantly conducive to improving the collocational production and comprehension of Iranian EFL learners. The researchers argued that increasing learners' awareness about collocations and their use is an effective way to boost their language performance.

Rezvani and Sadrosadat (2020) explored the influence of utilizing concept mapping on the retention of collocations. Ninety EFL learners were chosen and divided into control and experimental groups to receive conventional instruction and concept mapping, respectively. The findings confirmed that integrating concept mapping into instructional practices can effectively enhance collocation learning among learners.

In another study, Arifani (2019) studied how using WhatsApp application and a flipped-classroom context could boost Indonesian EFL learners' mastery of English collocations. They compared two flipped classrooms: one held via small-group WhatsApp classroom and one individual-based WhatsApp flipped classroom. They measured learners' collocational performance in a series of oral and written production and comprehension tasks and used a questionnaire to measure learners' attitudes as well. They found that group-based instruction practicing collocations in small

groups produced significantly more effective results than the individual-based one. Besides, learners' attitudes toward small-group flipped classrooms were more positive than their counterparts.

More recently, Jeensuk and Sukying (2021) used both receptive and productive tasks to measure 314 learners' collocational performance, including both lexical and grammatical performance. Interestingly, high schoolers with different proficiency levels were generally weak in comprehending and producing English collocations, which shows how these word combinations may prove problematic to EFL learners across various proficiency levels. As these studies show, different techniques of teaching have had positive effect on learning collocation. However, there is little research on how different types of mind map affect receptive and productive knowledge of collocations. Therefore, the present researchers were motivated to fill this gap.

3. Method
3.1. Participants
The participants included 120 male Iranian English language students at upper-intermediate level of proficiency. The participants were selected based on availability through convenience sampling from Qalam institute in Tehran. Their age range was from 15 to 18, and they were native speakers of Persian. The participants were placed in four groups, three of which were experimental groups and one control group. There were 30 students in each group. Three types of mind maps were used in these experimental groups, and the traditional way of teaching collocations was used in the control group.

3.2. Instruments
In the current study, pretests, teaching materials, and posttests were used to collect data. Their descriptions are given below.

3.2.1. Pretest
The researchers gave a pretest to ensure that all the selected collocations were unfamiliar to the participants. The researchers developed 180 collocational items in fill-in-the-blanks form, each blank to be filled with one of the target collocations. To make sure that the purpose of the item is clear to the participants, the Persian equivalents of the target collocations were given inside parentheses. All of these collocations were assumed to be unknown to the students. Any collocation with a response rate of more than 5% was removed from the posttest. This ensured that all the collocations were new to the students. The pretest contained sentences from the ***English Collocations in Use, 2nd Edition*** book, from which some words were removed. The participants had 90 minutes to answer the questions.

3.2.2. Teaching Materials

The materials used to present the target collocations were in both paper and electronic formats. In each experimental group, the researchers showed the collocations in a specific type of mind map on a monitor visible to all the students. The researchers also gave a paper to the students in which the target collocations were presented in mind maps. Students were able to see all the collocations in the mind map format in both their papers and the monitor. The researchers used three types of mind maps for the experimental groups and ***English Collocations in Use,* 2nd Edition** book, advanced level, as a learning material for the control group.

Three types of mind maps, which consisted of bubble, double-bubble, and multi-flow maps, were used. Bubble map was circular in shape. The main verb was written in the center of the map inside a large bubble, and the related nouns were written in smaller-sized bubbles surrounding the main bubble. The bubbles were connected with lines to show the relationship between them.

Figure 1

A Sample of Bubble Map
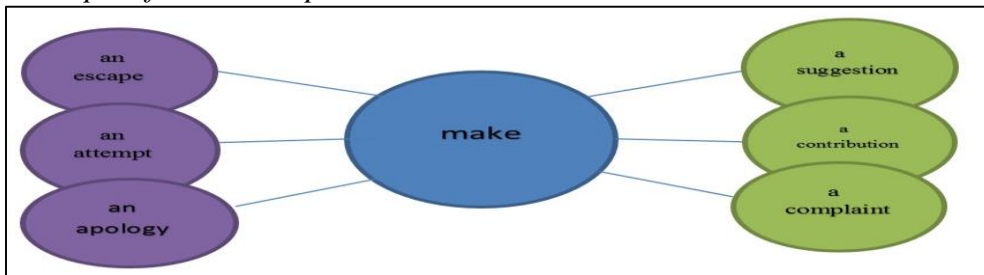
Taken from Okada et al. (2014)

The double-bubble map consisted of two large bubbles which were filled with two main verbs placed side by side. Each large bubble was surrounded by smaller bubbles that contained the related nouns. The smaller bubbles on each side were connected to the corresponding large bubble with lines. The bubbles on each side were color-coded to differentiate between the two entities being compared. The smaller bubble(s) which were placed between two large bubbles, were the common noun(s) which came with both main verbs.

Figure 2

A Sample of Double-Bubble Map
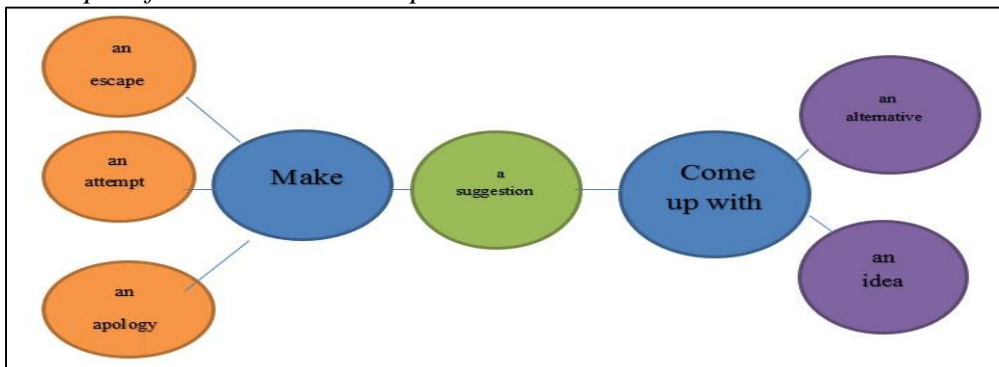
Taken from Okada et al. (2014)

The third one was multi-flow map, which was rectangular or square. The left side box(es) indicated the main verb(s), and there was a box in the center of the map for indicating modifier, whereas the right box(es) indicated the noun(s). The arrows traveled from left to right. The boxes on either the left or the right side of the mind map were plural. In some cases, both sides had many boxes. This type of map is great for formulating a coherent sequence for data sets, especially collocations.

Figure 3

A Sample of Multi-Flow Map
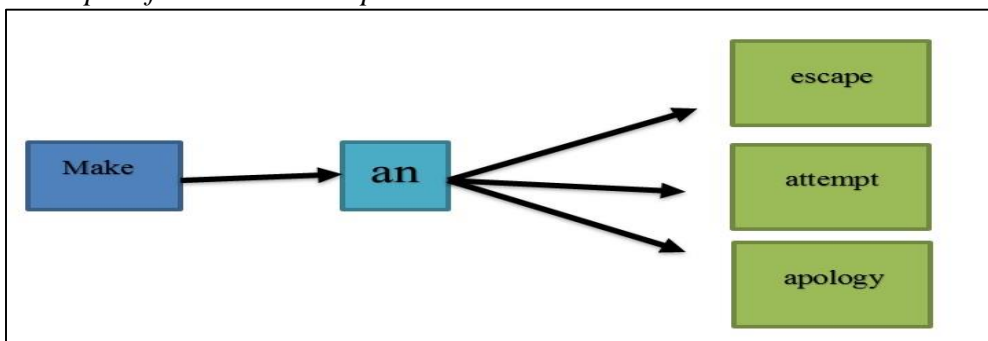
Taken from Okada et al. (2014)

3.2.3. Posttests

After the treatment, the researchers gave two posttests. The first one was a recognition test, which assessed the comprehension of English collocations. For this purpose, the researchers developed 30 items in multiple-choice format, in each of which a component of a collocation was missing, and the words that could complete those components appropriately were given in the alternatives. The second test was a production test which evaluated the production of collocations. The researchers designed 30 items in fill-in-the-blanks format. Each item included a stem that contained one of the target

collocations. In each item, one element from each collocation was missing. The students supplied their own words for the blanks. In some cases, more than one response could be possible. Therefore, a clue (Persian equivalent) was provided to elicit a specific response for each item. The content of both posttests came exactly from the materials presented. The participants had 30 minutes for each post-test.

3.3. Data Collection Procedure

To begin with, the researchers selected 120 participants with the characteristics mentioned earlier through convenience sampling based on availability. They were given the 180-item pretest, and they had 90 minutes to respond. The pretest contained sentences from which some words were removed. To complete this task, the participants had to produce the target collocation that matched the Persian meaning and started with the given letter for each blank. The items to which more than 5% of the students responded correctly were eliminated. One hundred and seventy-seven remaining collocations became our target collocations. The pretest of collocations was given to ensure the novelty of the target collocations. The researchers divided the number of target collocations by the number of sessions to specify how many collocations should be presented in each session. Therefore, it was decided to present eight collocations in each session.

For treatment, all the four groups participated in 12 class sessions of the course. Each session was 60 minutes. During the classes, we taught collocations to all the four groups. However, each of the three groups was taught using a specific kind of mind map, while the control group was taught in a conventional way.

Next, the treatment began. Each of the experimental groups received treatment through one type of mind map, i.e. bubble map (Group A), double-bubble map (Group B), and multi-flow map (Group C). The control group (Group D) received conventional instruction. In these four groups, the entire time of the class was allotted to working on the eight target collocations.

In the experimental groups, students were able to follow collocations on both paper and the monitor while paying attention to the teacher's presentation. First, new collocations were displayed on the screen, and the students were given a paper with the same mind map and collocations that appeared on the screen. The mind maps were designed by the researchers. The teacher explained what collocations are and how the mind map presents them. Then, the teacher pointed to the collocations one by one and made two sentences with each collocation at the students' level. The students had to guess the meaning of the sentences. After some guesses, the teacher provided guidance to approach the exact meaning and, finally, clarified the meaning of the collocations. The teacher, then, made another sentence above their level

and wrote it on the board. The learners were expected to guess the meaning of that sentence and paraphrase it. The teacher offered feedback to the errors of students during the production of their paraphrase sentences. Next, the teacher asked the students to write two sentences on a piece of paper in a specific context determined by the teacher. Then, they passed their papers to their partners, and their partners underlined the lexical or grammatical errors and circled the wrong collocations, if there was any. This process continued until all the collocations were taught. The papers were given to the teacher. The teacher evaluated the sentences and the feedback of the partner and scored them out of 20. The teacher asked the students to write one paragraph using these collocations in a specific subject as homework. Again, the teacher evaluated their homework and provided corrective feedback if necessary (Zohrabi & Khalili, 2024).

The students in the control group learned collocations without any kind of mind mapping and followed the target collocations in their book. At the beginning of the class, the students were given 5 minutes to get familiar with the content of the lesson and take a look at the collocations in each sentence. The students underlined every word that was unknown to them. Then, the teacher read those sentences aloud one by one and asked some questions about the meaning of the difficult words. After some guesses, the teacher gave some corrective feedback if necessary and clarified the meaning of the words and sentences. The teacher emphasized the meaning of collocations and elucidated their meaning. The teacher stated another sentence with each collocation and followed the previous process. Next, the teacher gave the students 2 minutes to write another sentence for each collocation in the specific subject, which was determined by the teacher, on a piece of paper. This process continued until all the collocations were taught. Then, the students had to give their papers to the teacher, and the teacher gave some corrective feedback to their sentences. After that, the teacher devoted 5 minutes to doing each exercise that existed on the second page of every lesson. The students commonly did the majority of exercises in class, and only one exercise remained for homework. The students had to do the exercises in pairs, and after a certain time, they read them aloud to prevent errors. The exercises in the book included both recognition and suppletion items. The partner of each student was determined by the teacher at the beginning of the class. After 24 hours, the students sent their homework to the teacher, and the teacher gave necessary feedback by email.

After about six weeks, the researchers gave the two posttests to measure how well students could comprehend and produce the target collocations. These tests were given after the treatment period was over. The 30-item multiple-choice test assessed students' comprehension, and it took 20 minutes. The 30-item fill-in-the-blanks test assessed their production of

collocations, and it took 30 minutes. Each correctly answered item had one point. The collected data were prepared for statistical analysis.

3.4. Data Analysis

Having collected the required data, the researchers used descriptive statistics to summarize the participants' performance on the posttests. One-way analysis of variance (ANOVA) was utilized to determine if the differences among the scores of the four groups on the posttests are significant. Tuckey HSD was used to locate the significant differences.

3.5. Design of the study

This study used a pretest-posttest-control group design. Although the assignment of the participants to the different treatment conditions was done on a random basis, the initial selection of the sample could not be done randomly. Therefore, the design of the study was quasi-experimental.

4. Results and Discussion

4.1. Results

4.1.1 Assumptions

Before using ANOVA, its assumptions were checked. According to Tables 1 and 2, there was no significant violation of the assumption of normal distribution of data.

Table 1

Tests of Normality for Collocations Comprehension

Mind mapping Kolmogorov-Smirnov

	statistic	df	Sig.
Bubble map group	.091	30	.200
Double-bubble map group	.158	30	.054
Multi-flow map group	.130	30	.200
Control group	.099	30	.200

Table 2

Tests of Normality for Collocations Production

Mind mapping Kolmogorov-Smirnov

	statistic	df	Sig.
Bubble map group	.108	30	.200
Double-bubble map group	.145	30	.109
Multi-flow map group	.159	30	.050
Control group	.096	30	.200

The second assumption of ANOVA is homogeneity of variances. According to Table 3, nonsignificant results indicated that this assumption was not violated either.

Table 3
Test of Homogeneity of Variances

Comprehension	Levene's statistic	df^1	df^2	Sig.
Comprehension based on Mean	.411	3	116	.746
Production based on mean	.874	3	116	.457

The other assumptions of ANOVA, including interval scale of measurement, independence of observations, and sample size were also met. Having ensured that the assumptions of ANOVA have not been violated, the researchers investigated each research question using a separate ANOVA procedure.

4.1.2 Research Question 1 (Collocations Comprehension)

To answer the first question, an ANOVA was performed using descriptive statistics, as shown in Table 4.

Table 4
Descriptive Statistics for the ANOVA on Collocations Comprehension

	N	Mean	Standard deviation
Bubble map group	30	24.83	3.68
Double-bubble map group	30	24.97	3.25
Multi-flow map group	30	24.70	3.90
Control group	30	22.07	3.62
Total	120	24.14	3.77

According to Table 4, the lowest mean score on the comprehension of collocations belongs to the control group. This is followed by multi-flow map group and the bubble map group; the highest score belongs to the double-bubble map group. ANOVA was used to see if the differences on the post-test of collocations comprehension were significant; the results are shown in Table 5.

Table 5
ANOVA Result on Collocations Comprehension

	Sum of squares	df	Mean square	*F*	Sig.
Between Groups	173.292	3	57.764	4.393	.006
Within Groups	1525.300	116	13.149		
Total	1698.592	119			

According to the results, group differences are statistically significant, $F_{(3,116)} = 4.393$, $p < .005$. The different techniques of mind mapping have differential effects on the learners' collocations comprehension. Tukey HSD post hoc test was used to locate the differences.

Table 6

Multiple Comparisons of Means for Collocations Comprehension

(I)	(J)	Mean difference	Sig.
Bubble map group	Double-bubble map group	-.133	.999
	Multi-flow map group	.133	.999
	control group	2.767[*]	.020
Double-bubble map group	Multi-flow map group	.267	.992
	Control group	2.900[*]	.013
Multi-flow map group	Control group	2.633[*]	.029

According to the results presented in Table 6, all the mapping groups performed significantly better than the control group. Furthermore, no significant differences were observed among these three mind mapping groups.

4.1.3 Research Question 2 (Collocations Production)

To find the answer to the second question, another ANOVA was used; descriptive statistics are shown in Table 7.

Table 7

Descriptive Statistics for the ANOVA on Collocations Production

	N	Mean	SD
Bubble map group	30	21.87	4.142
Double-bubble map group	30	22.07	3.513
Multi-flow map group	30	21.63	3.327
Control group	30	19.37	3.253
Total	120	21.23	3.696

As shown in Table 7, the double-bubble map group has the best mean score. The second best mean score belongs to the bubble map group. The multi-flow map group has the third highest score, and the control group has the lowest mean score. ANOVA was used to check the significance of the differences among the four groups.

Table 8

ANOVA Result on Collocations Production

	Sum of squares	df	Mean square	F	Sig.
Between Groups	142.200	3	47.400	3.707	.014
Within Groups	1483.267	116	12.787		
Total	1625.467	119			

Table 8 suggests that group differences are statistically significant, $F_{(3,116)} = 3.707$, $p < .005$. Our different techniques of mind mapping have significantly differential effects on collocations production. The Tukey HSD test was used to see where the differences lie.

Table 9
Multiple Comparisons of Means for Collocations Production

(I)	(J)	Mean difference (I-J)	Sig.
Bubble map group	Double-bubble Map group	-.200	.996
	Multi-flow map group	.233	.994
	Control group	2.500**	.039
Double-bubble map group	Multi-flow map group	.433	.966
	Control group	2.700**	.021
Multi-flow map group	Control group	2.267	.073

As reported in Table 9, the bubble and double-bubble map groups outperformed the control group. However, no significant differences were seen between the multi-flow map group and the control group as well as among the three mapping groups.

4.4 Discussion

With regard to question one, which explored if there were any statistically meaningful differences among bubble, double-bubble, and multi-flow maps affecting the comprehension of English collocations, the results of Tukey HSD test revealed that the bubble, double-bubble, and multi-flow map groups performed better than the control group. Moreover, there were no statistically significant differences among these three mind mapping groups. This result is partially in agreement with some studies (e.g., Rezvani & Sadrosadat, 2020; Seyedi et al., 2023), which have shown that utilizing mind maps can positively influence the comprehension of collocations.

Numerous scholars have endorsed the significant role of visual aids in the language acquisition of children and young students, particularly in vocabulary development (Schmidt & Schmidt, 2015). Concept mapping is seen as the connections between various elements. The process of learning words is made simpler when there is a link between them. A key reason for the effectiveness of mapping is cognitive engagement. Shapiro and Waters (2005) propose that increased cognitive effort results in an enhanced retention of vocabulary, a notion corroborated by Morin and Goebel (2001), who posit that semantic mapping encourages deep cognitive involvement.

An additional plausible explanation could be that the use of various mind maps to learn collocations allowed the participants in the experimental groups to establish semantic networks and various associative connections that ultimately improved the learning of new collocations. This aligns with

Schmitt's (2008) analysis of second language vocabulary acquisition. In his assessment, Schmitt recognized the advantages of acquiring lexical items through associations in meaningful and captivating contexts. Different mind maps acted as a bridge between the text and learners by offering additional insights into collocations and aiding in the understanding and comprehension of English collocations.

As Heidari and Karimi (2015) argued, a potential topic for discussion is that mind maps may be used to display connections and strengthen them in the minds of students. Essentially, mind-mapping served as a form of semantic map, helping the experimental group learners to identify semantic connections between words and their typical collocations. Through mind mapping, the participants may have highlighted the semantic distinctions and similarities among lexical terms.

As mentioned before, no significant differences were observed among the three mind mapping groups. Unlike graphic organizers, which are highly varied and inconsistent, different mind maps are commonly found to be consistent (Feng et al., 2023). This ensures that students develop automaticity with the major thought processes by using different mind maps to engage the cognitive processes they represent. As students build fluency with the mind maps, they internalize these cognitive skills and learn how to become better learners, thinkers, and communicators (Rezvani & Sadrosadat, 2020).

With regard to the second research question, the results suggested that the bubble map and double-bubble map groups performed statistically better than the control group. However, the three mappings groups were almost equal. Meanwhile, the multi-flow map group and the control group had similar effects. The findings are in line with what Kazemi et al. (2019) observed. The findings can be explained in the light of the fact that the utilization of mind maps could have led to the *noticing* of collocations by learners. It is an undisputed fact that noticing is a widely acknowledged concept in SLA research and has a key role in the absorption and long-term retention of information (Ellis, 2008). Drawing on the notion of *noticing* the difference, learners are advised to consciously analyze how their interlanguage varies from the target form and to focus on and acknowledge the subtle elements of the input provided in order to incorporate it into their output.

The use of bubble map or double bubble map in the experimental groups might have assisted language learners to divide their problem into different components and develop the most effective solution accordingly. Furthermore, according to Zarei and Keysan (2016), using mind maps can foster students' peripheral and focused learning, culminating in more authentic interactions among students.

In contrast with conventional training in the control group, the utilization of the mind-mapping technique was more effective in improving the

comprehension of collocations. The incorporation of symbols and images probably captured the learners' attention and contributed to a more engaging learning experience. Additionally, the use of mind mapping may have facilitated a quicker retention of vocabulary for EFL learners. This is also in line with what Rezvani and Sadrosadat (2020) observed.

5. Conclusion and Implications

Learning collocations is an important aspect of EFL education. Knowledge of collocations is known to enhance language proficiency, boost communicative abilities, and achieve native-like fluency (Bui, 2021). Therefore, the comprehension and production of collocations are necessary for EFL learners, necessitating such instruction. EFL instructors are advised to integrate collocations into their lesson plans and motivate students to practice them in daily conversations.

The results regarding the effect of different types of mind mapping were expected, as previous studies have shown their positive effect on vocabulary learning. In the comprehension of collocations, since all the three types of mind maps were similar to each other and better than the control group, it can be concluded that all types of mind maps are highly effective methods for the comprehension of collocations. This implies that blind adherence to any of the mind mapping techniques is not advisable. Due to the differences in the learning preferences of students, a combination of different mind-mapping techniques may render better results than the overuse of any single mind-mapping technique. Variety in the use of mind-mapping techniques can not only allow learners with different learning preferences to benefit from one type of mind mapping or another, but also prevent the possible monotony resulting from the repeated use of a single technique.

As for the production of collocations, significant differences were observed between the bubble map and double-bubble map compared to the control group. However, the multi-flow map and the control group were similar, indicating a distinction between the processes of producing and comprehending collocations. The conclusion to be drawn from this is that the type of mind mapping used can impact the production of collocations and its outcomes. Concerning the multi-flow map, it is conceivable that factors such as the intricacy of teaching, sample size, and learner characteristics may have influenced the results. Consequently, additional research is needed to check the effect of this technique in teaching collocations.

Generally, the results of this research suggest that double-bubble map and bubble map are highly effective methods for teaching collocations in EFL classrooms. They enable students to collaborate and engage creatively with collocations. Through these mind maps, students are able to devise innovative

and interesting ways to incorporate collocations into their learning, enhancing engagement and retention.

To summarize, this study provides insights into the effectiveness of different instructional methods for teaching collocations in EFL classrooms. Generally, mind mapping was proved as an effective method to teach collocations. These results may be interesting for *language instructors*, *language learners, researchers, and material developers.* Language instructors have always been looking for effective teaching techniques to make language learning more interactive, beneficial, and pleasurable. The results of this research can help them optimize their teaching methods and provide learners with tailored materials that are optimal for learning.

Knowing which technique is the best for learning collocations can help learners make more informed decisions about how to learn. They will also be more likely to accept and use these techniques when teachers use them. In addition, researchers always look for methods and techniques that foster creativity. Therefore, the results of this research can inspire them to do further research. Moreover, material developers may find the results beneficial in improving existing language learning materials or developing new ones. They can utilize mind mapping as an effective technique to teach collocations, when developing new materials for teaching collocations.

Nonetheless, given the limitations of this study, including the number of participants, the duration of the treatments, and the selected mind-mapping techniques (to name only a few), further research is warranted to solidify our understanding and shed further light on this area.

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