Supporting EFL Reading Comprehension by Using of KB-Mapping Method and Analysis of Cognitive Process

（　英文読解支援へのキットビルド概念マップの活用とその認知プロセスの分析　）

By

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DISSERTATION SUMMARY

In language learning contexts, reading comprehension (RC) is an important learning activity that requires a special ability from the learner to reap its benefits. RC poses many challenges since learners may experience such issues as slow reading, insufficient vocabulary comprehension and poor recalling. In general, RC involves two levels of processing, shallow and deep processing. Deep processing involves semantic structural processing, which happens when we encode the meaning of a word and relate it to similar words. Shallow processing involves grammatical structural and phonemic recognition, the processing of sentence and word structure and their associated sounds. Some researchers have described memory recall of stimuli as a function of the depth of mental processing. For the purpose of this research the reading comprehension is defined as "the learner's ability to understand completely and memorize the important information that is included in the text that he is reading".

RC in a Foreign Language (FL) context is a special case of RC; it is a complex, dynamic, multi-componential and multi-dimensional task in the learning process. It is a continuous process of multiple interactions between the readers' background knowledge in their Mother Language (ML) and the knowledge exposed to in the FL. Broadly speaking, RC of FL is the same as the ML reading comprehension, but it is slower and less successful than ML reading. This can be explained by the fact that the reading process is dependent on many factors such as the level of the readers' language proficiency, the subject matter of the text, text difficulty and task demands.

Kit Build concept mapping (KB-mapping) method is a special kind of graphical organizers of information, and it has proved the efficiency of KB-mapping in many learning fields. In advance, it has some special properties which help the learners to get a better understanding. We planned to investigate the effects of applying this method in supporting EFL RC. In this thesis, we are proposing the method of KB-mapping as a method to support this learning activity. KB-map is "a framework to realize automatic diagnosis of concept maps built by learners and to give feedback to their errors in the maps". Kit Build concept map (KB-map) is a special kind of concept map. In general, the creation of concept map consists of two steps: the extraction of the concepts and the relations from the text and the selection of the responsible

relation that connects two concepts together. In KB-mapping, the supervisor makes the first step by creating the goal map from text and after that, he can generate the kit from the goal map by dividing the goal map into a separate concepts and relations, providing learners with this kit. After that, learners are tasked to build the concept map (called learner's map) by using the concepts and the relations that provided in the kit.

One of the important research field in FL RC is the English as Foreign Language (EFL), this research topic is very important and common in all countries. Also the results of the research in this domain in any language can be applied for any other language. In this thesis, we are investigating the usability of KB-mapping method in supporting RC of English text, as EFL.

In the learning engineering research, when proposing a new method to support a learning task, it is important to explain "what are the effects of this method on learners' behaviour, understanding and comprehension". Also it is important to explain "why this method is effective". In this research, to do so, we propose to examine of the cognitive process of the learners during the learning process. In order to check the effects of use, we have compared the proposed method with two commonly used graphical organizers in EFL RC, Selective Underlined strategy (SU), which is a common used strategy in the classes of EFL RC, and Scratch Build (SB) concept mapping method, which has been investigated as advanced method to support EFL RC. We have found that KB-mapping has the same efficiency as the other, form the short term viewpoint, but it has better efficiency from the long term viewpoint. Also to explain these results, we have analysed the cognition process of learning EFL RC by using KB-mapping and SB-mapping methods. We have found that KB-mapping method helps the learners to avoid sentence by sentence map building style, and SB-mapping method does not. Throughout the experimental use, the main difference between the KB-mapping and SB-mapping method is the map building process, the progress of map building is a very important factor, it can express the performance of the learners during the learning process, and also it can give important information about the learners' comprehension. We have examined the cognitive process throughout the progress of map building, by monitoring the map building process and compare with the text sequence. The outline of this dissertation is elaborated in the following passage.

In **Chapter 1**, the introduction about supporting EFL RC is presented. A throughout survey of some related researches which tried to support this learning activity is presented in **Chapter 2**. In **Chapter 3,** we introduce the SU strategy and the KB-mapping method in details, and

describe an experiment, that is comparing KB-mapping method with the SU strategy, which is common used strategy in the classes of EFL reading comprehension. This experiment indicated that KB-mapping method had the same efficiency as SU strategy for the short term viewpoint, but it has a better efficiency for the long term viewpoint. In **Chapter 4,** the details of SB-mapping method are introduced, another experiment, that is comparing KB-mapping and SB-mapping methods. This experiment indicated that KB-mapping method had the same efficiency as SB-mapping method for the short term viewpoint, but it has a better efficiency for the long term viewpoint. The following chapter **Chapter 5** describes another experiment compared again KB-mapping method with SB-mapping method, applying more detailed investigating method for the cognitive process by monitoring the building progress of the two methods, in order to investigate "Why KB-mapping method is more effective than SB-mapping method in recalling the comprehended information after a while". Finally, further discussion, the conclusion of this assentation and future work directions are given in **Chapter 6**.

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ABBREVIATIONS

KB	Kit Build
SB	Scratch Build
EFL	English as Foreign Language
R.C	Reading Comprehension
GOs	Graphic Organizers
CT	Comprehension Test
DCT	Delayed Comprehension Test
SU	Selective Underlining
AD	Anagram Distance
TF	Text following Sequence
LS	learner's building Sequence
AD	Anagram Distance
TF	Text Following

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1 INTRODUCTION

Reading, a critical aspect of literacy, is regarded as an interaction between the reader and the text. Moreover, reading is purposeful and requires active involvement on behalf of the readers, as readers have specific goals to achieve, when reading a text [1]. Though early attempts of reading instruction mainly emphasize on students' ability to decode and learn how to read, radically there is a shift in the reading process putting the emphasis on comprehension and text learning. However, there are a number of students who have difficulties in text comprehension and successful task completion, especially when they encounter difficult and long passages. Learners, particularly the struggling ones, can be actively involved in reading and derive meaning from written texts using reading comprehension strategies. Among the various reading strategies, graphic strategies are considered to approach reading differently from the traditional, linear text presentation [2].

1.1 Reading Comprehension (RC)

Reading comprehension RC is the ability to read text, process it and understand its meaning. An individual's ability to comprehend text is influenced by their traits and skills, one of which is the ability to make inferences. If word recognition is difficult, learners use too much of their processing capacity to read individual words, which interferes with their ability to comprehend

what is read. There are a number of approaches to improve RC, including improving one's vocabulary and reading strategies.

1.1.1 Definition

The “Reading” as a concept is defined as “Have the ability to look at and comprehend the meaning of written or printed matter” in Oxford dictionary, and as “to look at words or symbols and understand what they mean” in the Cambridge dictionary. Also the “Comprehension” concept is defined as “The ability to understand something” in Oxford dictionary, and as “the ability to understand completely and be familiar with a situation, facts” in the Cambridge dictionary. Also some researches [3] had confirmed that the RC involves two levels of processing, shallow (low-level) processing and deep (high-level) processing and the level of processing is indicator to the level of comprehending. These researches describe memory recall of stimuli as a function of the level of processing and the level of comprehending. So from the previous definitions, we can define the RC in our research as” the learner’s ability to understand completely and memorize the important information that is included in the text that he is reading”.

Fergus and Lockhart [8] had proposed a theory that the RC involves two levels of processing, shallow (low-level) processing and deep (high-level) processing. This theory describes memory recall of stimuli as a function of the depth of mental processing. Deeper levels of analysis produce more elaborate, longer lasting, and stronger memory traces than shallow levels of analysis. Depth of processing falls on a shallow to deep continuum. Shallow processing (e.g., processing based on phonemic and orthographic components) leads to a fragile memory trace that is susceptible to rapid decay. Conversely, deep processing (e.g., semantic processing) results in a more durable memory trace. Many researches have used the memory recalling as indictor to measure the level of comprehension, they have proposed the delayed comprehension test (after a while) as a test for the depth of comprehension [9] [10]. As an example, Mayer and Bluth [11] have proposed to check the recalling immediately, and one week later. Due to this theory, we measured the level of RC by using two kinds of test, the Comprehending Test (CT), which was done just after the practical use, to check the

comprehended information from the text (Shallow processing), and the Delayed Comprehension Test (DCT), which was done two weeks after, in order to measure the recalled information (Deep processing).

1.2 English as Foreign Language Reading Comprehension (EFL RC)

RC is defined as the level of understanding of a text/message. This understanding comes from the interaction between the words that are written and how they trigger knowledge outside the text/message. And as we mentioned in section 1.1.1 'RC' is defined as "a learner's ability to understand completely and memorize the important information that is included in the text he/she is reading". The definition necessarily includes the level of understanding of a text/message. Such an understanding comes from the interaction between the written words and how the learners trigger knowledge outside the text/message [4]. Throughout this definition, the level of comprehending must be examined from two points, the understanding and the memorizing, so we proposed two types of test the comprehension test (CT), which is conducted just after the reading task to examine the level of understanding, and the delayed comprehension test (DCT), which is conducted after a while to examine the level of memorizing.

In general, the RC is a very difficult task for learners in all the stages of study especially when they are reading text in a foreign language, the English as foreign language (EFL) reading is one of the most common research topic in the learning field.

RC in an EFL context is a special case of RC; it is a complex, dynamic, multi-componential and multi-dimensional task in the learning process. It is a continuous process of multiple interactions between the readers' background knowledge in their Mother Language (ML) and the knowledge exposed to in the Target Language (here English). Broadly speaking, the RC of EFL is the same as the ML RC but it is slower and less successful than ML reading [4]. This can be explained by the fact that the reading process is dependent on many factors such as the level of the readers' language proficiency, the subject matter of the text, text difficulty and task demands.

There are many researches have tried to solve this problem by proposing methods or strategies to help the learners in this task, but most of them had slightly significant improving in the learners' comprehension just after using the method or the strategy. Some of these strategies are selective underlining strategy [5] [6], Note-Taking Skills Reading [6], SQ3R (Survey, Question, Read, Recite, Review) [7] and PORPE (Predict, Organize, Rehearse, Practice, Evaluate) [8]. Several investigations of RC strategies have specifically addressed challenges related to reading expository text. Positive outcomes have been found for students who were taught strategies to help students identify main ideas.

1.3 Sentence by Sentence Reading Style:

One of the most common styles of comprehension in the EFL RC learning activity is the sentence-by-sentence style [9]. Most of learners in EFL RC are tied to sentence-by-sentence comprehension [10], this comprehension style is effective for comprehending the English text from the short time point of view as in the CT, but it is not so effective for recalling the comprehended information after a while as in the DCT [11] [12] [13]. Throughout our research, we have found that the KB-mapping, SU strategy and SB-mapping methods have the same efficiency for comprehending the EFL text just after the method use, but KB-mapping method has a better efficiency for recalling the comprehended information later, So we have an assumption that KB-mapping methods to support the learners of EFL RC task to avoid the sentence-by-sentence style of comprehension.

Some researchers have proposed the concept of hermeneutic circle [14], which describes the process of understanding a text hermeneutically. It refers to the idea that one's understanding of the text as a whole, is established by reference to the individual parts and one's understanding

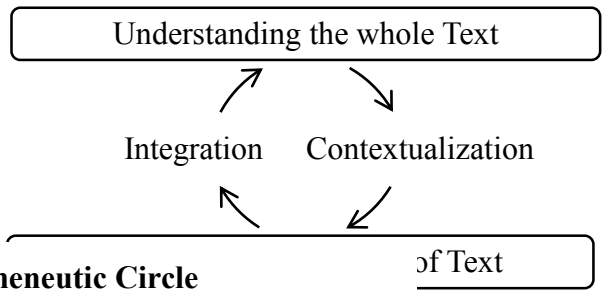


Figure 1-1. Hermeneutic Circle

of each individual part by reference to the whole. Neither the whole text nor any individual part can be understood without reference to one another, and hence, it is a circle, as shown in Figure 1-1, between the integration of parts to define the whole text, and the contextualization of the whole text to illuminate the parts of text.

However, this circular character of interpretation does not make it impossible to interpret a text; rather, it stresses that the meaning of a text must. By applying this circle for more times, the reader can get deeper understanding and he could remember and recall it after a while [15] as it shown in Figure 1-2.

1.4 Supporting Throughout Reading Stage:

The supporting strategies can be applied in different ways through the reading stages, the provided instructions are different according to the target stage. In general, providing instruction allows learners to see, learn, and use a variety of comprehension strategies as they read. All of the strategies could be used in one or more of the reading stage. As a summarization for the possible achieved goals from applying strategies in every reading stage, in the next

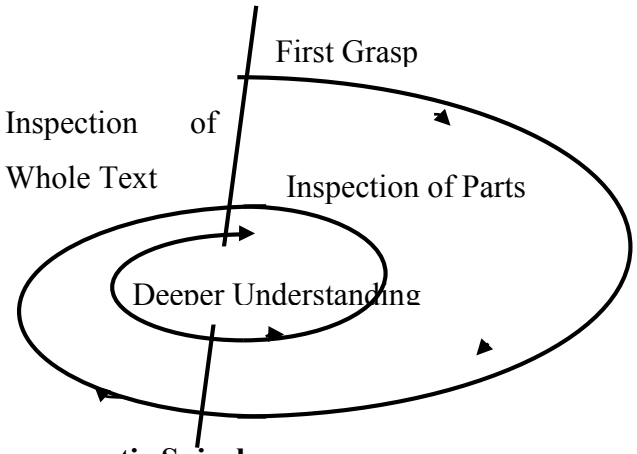


Figure 1-2. Hermeneutic Spiral

paragraph, we present the general effects of the applied strategy for the learners.

A). Before Reading

In this category, the strategy may motivate learners through activities that may increase their interest (book talks, dramatic readings, or displays of art related to the text), making the text relevant to them in some way. Also, it may activate learners' background knowledge in related

to the content of the text by discussing what readers will read and what they already know about its topic and about the text organization.

For learners, with some help from the strategy, they can establish a purpose for reading, identify and discuss difficult words, phrases, and concepts in the text, preview the text (by surveying the title, illustrations, and unusual text structures) to make predictions about its content, and think, talk, and write about the topic of the text.

B). During Reading

During reading, the teacher may (1) remind students to use comprehension strategies as they read and to monitor their understanding, (2) ask questions that keep students on track and focus their attention on main ideas and important points in the text, (3)focus attention on parts in a text that require students to make inferences, (4) call on students to summarize key sections or events, and (5) encourage students to return to any predictions they have made before reading to see if they are confirmed by the text.

For students, with some help from the teacher, they may could (1) determine and summarize important ideas and supportive details, (2) make connections between and among important ideas in the text, (3) integrate new ideas with existing background knowledge, (4) ask themselves questions about the text, (5) sequence events and ideas in the text, (6) offer interpretations of and responses to the text, (7) check understanding by paraphrasing or restating important and/or difficult sentences and paragraphs, and (8) visualize characters, settings, or events in a text.

C). After Reading

After reading, the teacher may (1)guide discussion of the reading,(2)ask students to recall and tell in their own words important parts of the text, and (3) offer students opportunities to respond to the reading in various ways, including through writing, dramatic play, music, readers' theatre, videos, debate, or pantomime.

For students, with some help from the teacher, they may could (1) evaluate and discuss the ideas encountered in the text, (2) apply and extend these ideas to other texts and real life

situations, (3) summarize what was read by retelling the main ideas and (4) discuss ideas for further reading.

2 RELATED WORKS: GRAPHIC ORGANISERS (GOS) TO SUPPORT EFL RC

GOs have received great attention and concern among general and special education researchers, as they depict a variety of relationships and structures in a single display [16]. Throughout the years, a lot of researchers have offered their own definitions. A simple and widespread definition is that GOs are "visual representation of information in the text" [17]. Katayama, Robinson, Devaney, and Dubois [18]consider GOs to be spatial displays of text information that can be given to students as study aids to accompany texts and communicate both vertical, hierarchical concept relations and horizontal, coordinate concept relations. Moreover, Alvermann [19] regards GOs as "a type of advance organizers that activates a reader's prior knowledge and depicts the organizational pattern of a reading selection by schematically representing key vocabulary terms" [19].

Having a closer look at the above definitions we can infer that they have some things in common: 1) GOs consist of words; 2) they indicate relations among concepts by using spatial arrangements of the information in the text; 3) they depict the organizational plan of the text [20]; and 4) GOs can be deployed in different kinds of texts (both narrative and expository texts). According to literature, a variety of terms is used to refer to GOs, such as visual displays, graphic(al) displays/representations, graphics and tree diagrams, structured over categories of Supporting throughout Reading constructed

a) Teacher-constructed: teacher-initiated GOs result in improved RC [19] [21].

b) Student-constructed: some researches yields positive results regarding GOs generated or even simply partially completed by students emphasizing on students' active involvement in the learning process [22] [23], we can say that as examples

- ✓ Free Build GOs (SB-Map method)
- ✓ Kit Build GOs (Kit Build concept Map)

C) Teacher/student constructed: support the effectiveness of teacher-student constructed GOs on text learning [24].

2.1 Story Map

It is used in narrative texts. Story maps call students' attention to the main elements of stories, such as characters, time, and setting, plot (problem, actions, and outcomes) and visually represent key information in narrative texts using a specific structure [25]. At the same time, they highlight significant relations within a story, which in turn leads to a deeper understanding [26]. They can be used before reading a passage to activate students' prior knowledge, link what they read to their background knowledge structure, develop a purpose for their reading; while reading a passage to guide them through texts, help them monitor comprehension and after reading a passage to facilitate summarization of the most important ideas [26]Research supports that story maps are a promising type of GOs, which can improve students' RC (Figure 2-1).

Therefore, story maps are used to facilitate comprehension of narrative texts, whereas the other types of GOs are mainly used to enhance comprehension of expository texts, which pose more challenges to students, as they may contain unfamiliar vocabulary, complex relations, and structures and are often more information driven making the text dense in information and weak in [27].

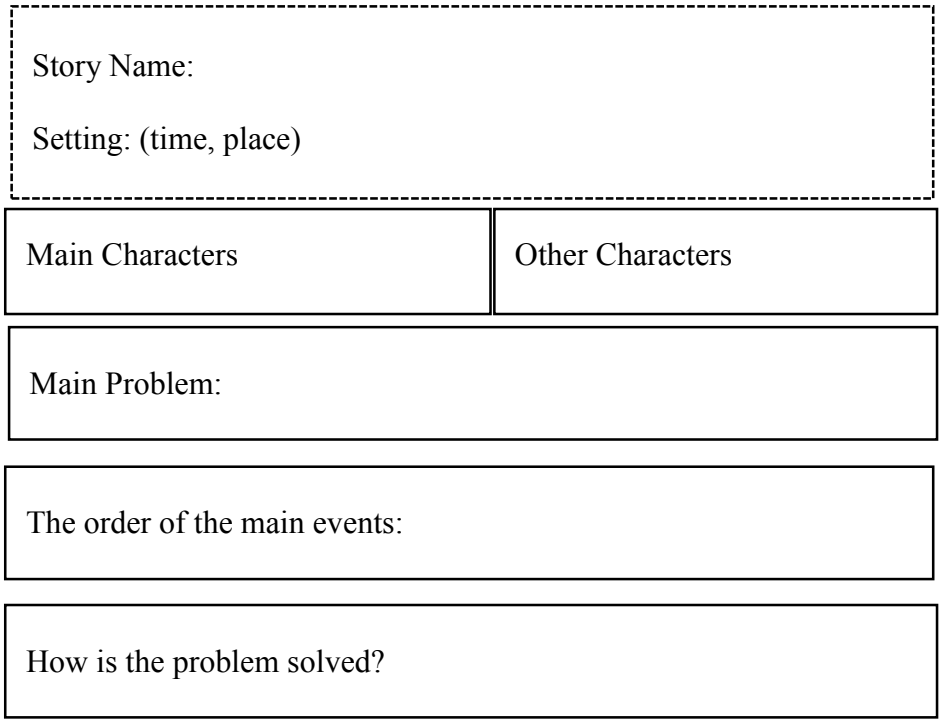


Figure 2-1. Story map Form [21]

2.2 Sematic Map

Semantic maps are web-like organizers. Mind maps, spider maps or sunbursts are some of the terms that are used to refer to semantic maps. They look "like a sun or star with rays emanating from it, as they consist of a circle with lines radiating from the circle" [28]. They are diagrams that can be used to represent words, ideas, or other items linked to and arranged around a central key word or idea of the text and depict relationships of the different components of an idea to the main idea, that is of the part to the whole [28] [29]. Namely, semantic maps place the main idea in the centre around which relevant notions or sub-concepts are linked. Concurrently, they offer an overview of key vocabulary and concepts providing a link between what students know and what will learn and read, a type of a brainstorming activity mainly used before reading a passage to stimulate students' background cognitive structure and assess their knowledge in terms of the specific topic [30]. The development of semantic maps is based on the schema

theory [31]. According to conducted research synthesis, the use of semantic organizers enhances students' comprehension skills. (Figure 2-2)

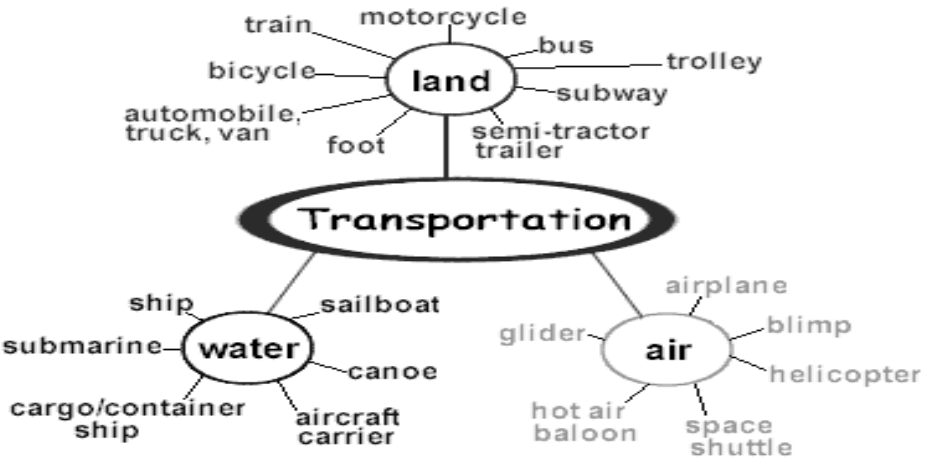


Figure 2-2. Semantic Map example

2.3 Knowledge Map

Another similar graphic organizer is the knowledge map. Knowledge mapping emerged from Dansereau's work [16] [32] [23]. A knowledge map is a two-dimensional graphical display presenting information in the form of node-link-node assemblies, which contains key ideas and specifies the relationships between nodes [23]. In addition, the nodes of a knowledge map depict conceptual information in the form of simple, verbal propositions and each link simultaneously has an arrowhead to indicate directionality [23]. Knowledge maps also emphasize on the way concepts and ideas in a body of information are related to an overall structure [16]. Studying knowledge maps consistently leads to better delayed recall of macro level ideas than merely studying texts [16] [23]. Conclusive results are provided by a review, which indicates that students, especially the less skilled ones, recall more central ideas, when they study a knowledge map [33]. However, as there is confusion in the classification of GOs throughout literature, knowledge maps are often related to concept maps. It should be pointed out that knowledge maps differ from other similar representations, such as concept maps, in

the deliberate use of a set of labelled links that connect ideas and have arrowheads to establish directionality among ideas [33] (Figure 2-3)

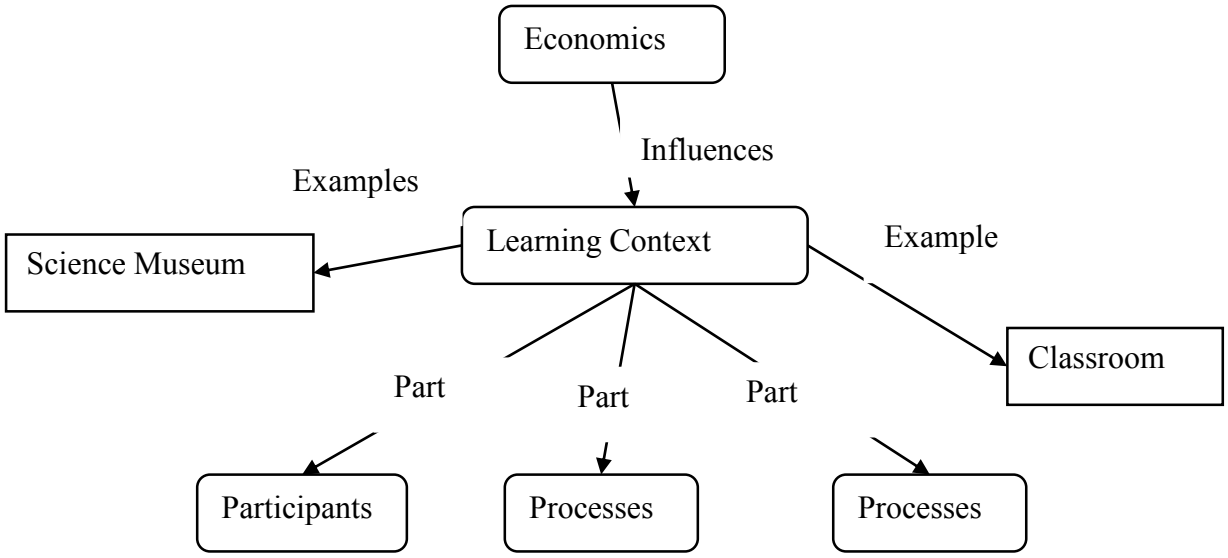


Figure 2-3. Example of Knowledge map [33]

2.4 Selective Underlining (SU)

SU is a simple strategy with a great benefit. The learners can share their knowledge with the other learners. By using SU, learners will know how to pick out the main ideas and information that are important to underline or highlight. In order, help them to organize and remember important information in the text. The basic rules of SU are to read first and then underline, and select only main ideas and supporting details. Also, it is used to help readers to organize what they have read by selecting what is important. This strategy teaches learners to underline only the key words, phrases, vocabulary, and ideas that are central to understanding the reading.

SU strategy is one of the most important strategies commonly used in classroom. Generally, it is used to help learners to organize the text, which they are reading by selecting the important sentences. This strategy teaches learners to highlight/underline only the key words, phrases,

vocabulary, and ideas that are essential to understanding the text [7] [34]. It is very useful for comprehending the text, because it is a flexible strategy that may be tailored to fit various types of information and different skill-levels. This strategy can also be integrated with the use of technology and electronic information such as eBooks. As students study, it helps them learn to pay attention to the essential information within a text [34]. In general, this strategy is focusing on the vocabularies and comprehension of the text during the reading time, also it helps the learners to identify the important points in text, helps them to pay close attention to what they are reading and also, allow greater learning and deeper comprehension.

Typically, in the SU strategy, the learner starts by reading the text to understand the main content of the text, after that, the learner rereads and begins to underlining the main ideas and their supporting details, then he selects the important facts and the key vocabularies [34]. By using the underlined part of the text, the learner can give a summary for the important information in the text that he has read. This strategy demands the learner to capture the main ideas, key concepts and details; also it helps learning by reducing the needed information in text, so it reduces the learning time and in the same time strengthens the RC.

2.5 Scratch Build Concept Map (SB-map)

One kind of graphic organizers that can affect learners' processing of expository texts is the cognitive/concept map. The development of concept maps is credited to Novak [35] [36]. According to Novak and Cañas [37], they include concepts, usually enclosed in circles or boxes, and relationships between concepts indicated by a connecting line linking two concepts, while there are words on the line, referred to as linking words or phrases, which specify the relationship between the two concepts. Early maps did not include labels on the lines, whereas later labels on the lines were regarded as necessary, because even experts could see different meanings between the same two concepts on a map. Another characteristic of concept maps is that they indicate hierarchical representation of concepts usually organized with the most general, most inclusive idea at the top of the map, with successively less general, less inclusive concepts in appropriate sub- ordinate positions [35] [37]. They can also represent multiple relationship types among concepts students would likely encounter in texts, such as

comparative, causative, explanatory, sequential facilitating RC [38]. As their primary function is to focus on the selection of the main ideas (key words) of the text, connecting these concepts using relation links and displaying the major framework of the text, concept maps are a useful tool to represent knowledge in any discipline contributing to organizing, understanding and recalling new material [38] [35].A current trend in concept maps emphasizes on an electronic version [37] [39] (Figure 2-4).

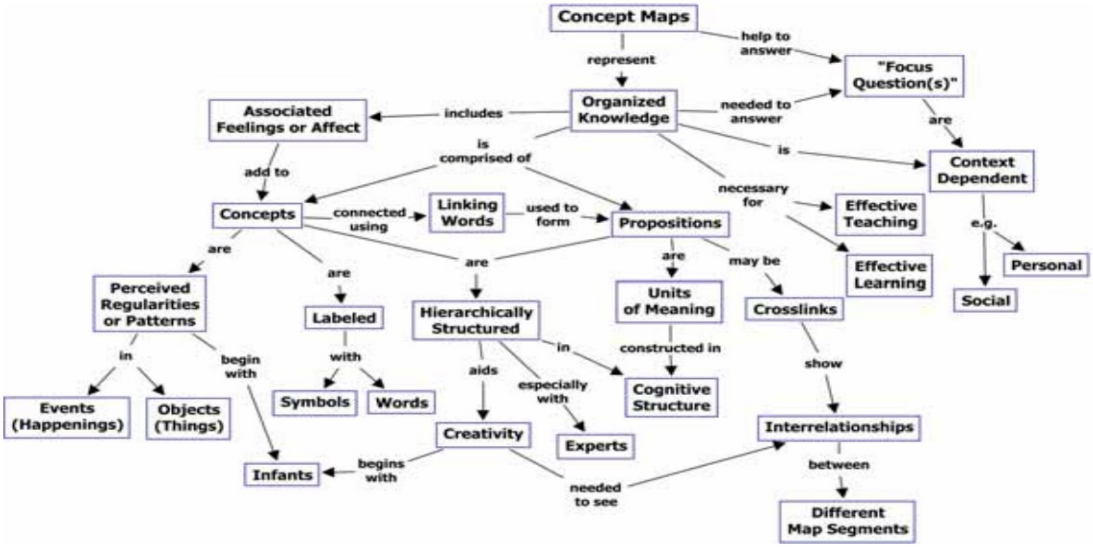


Figure 2-4. Example of SB-Map [35]

2.6 Summary:

In order to develop learners' RC, one of the most important goals is to raise their awareness of text structure through in-class explorations of discourse patterns with English texts [40]. Research efforts are needed to demonstrate the extent to which GOs will have an impact on the way EFL students read texts, as well as the long-term impact of GOs on students' reading development. These efforts will lead to a better understanding of the overall effectiveness of GOs in RC.

In general, all kinds of GOs contain words from the text, most of them contain the same essential words, but the difference between them is in the manner of presentation and the degree of structural presentation. Story map is the simplest example of GOs, it uses sentences to

express the main information of the text and arrange them in a specific form in order to represent the story of the text. Semantic map uses the form of spider net to connect the individual words in order to present the information. The knowledge map presents information in the form of node-link-node assemblies, which contains key ideas and specifies the relationships between nodes. The efficiency of every kind of GOs are differ according to which reading stage applied in, based on research [17] GOs can be used in education in different ways in all reading stages producing different effects on comprehension. The instructional procedures vary depending on the position of GOs in relation to reading (pre-reading, post reading stage) and the constructor of GOs (teacher-constructed, student-constructed, teacher/student constructed). Table 2-1 shows the possibility to use the previous presented GOs.

Table 2-1. GOs use in reading stage and constructor

GOs	**Reading Stage**			**Constructor**	
	Pre-reading	Through-reading	Post-reading	Teacher	learner
Story map			○		○
Semantic Map			○	○	
Knowledge Map		○	○	○	○
SU		○	○		○
Concept Map	○	○	○	○	○

2.7 GOs Researches Needed in Supporting EFL RC

EFL students are a particular population who needs special attention in reading development, especially those who need to read academic work in their second language. Learning how to read informational texts to obtain content-area knowledge becomes critical for their success. Reading to learn from texts involves abilities to remember main ideas and certain details, to link the text to the reader's prior knowledge, and to recognize and build rhetorical frames which organize the text information [41]. One of the major challenges EFL students face in academic

settings is learning to comprehend increasingly more dense and complex reading material, especially when the rhetorical convention of English texts may differ from that of ML texts.

There is evidence that a specific type of GOs, concept maps, is a useful strategy for EFL students [12] [40] [24], few studies investigated the effectiveness of GOs on EFL RC. To be more precise, Tang [42], who examined the relation of graphic representation of text structure to comprehension with EFL students, indicated great gains in the amount of information recalled. Furthermore, Amer [43] probing into the effect of deploying knowledge maps and underlining on students' comprehension of English scientific texts found that both experimental groups outperformed the control group on summarization, while the knowledge map group performed slightly better.

Another study [24] focusing on the effects of three semantic mapping strategies (teacher-initiated, student mediated, teacher-student interactive mapping) on comprehension of ESL students revealed that learners in the teacher-student interactive mapping group scored significantly higher than the other two groups. Additionally, Chularut [44] demonstrated facilitative effects of the use of GOs on EFL students' text learning, self-efficacy and self-monitoring.

Overall, the researches of using GOs are limited and they has yielded conflicting results regarding the effectiveness of GOs on learners' retention and comprehension of text information [19] [43] [45] [12]. However, much of the empirical research on actual instructional effects of GOs on RC has centred on ML readers rather than EFL readers. Most carefully designed studies are conducted with ML readers. The lack of research with EFL readers is apparent, and explorations of the effects of GOs with EFL students are especially necessary.

3 COMPARING KB-MAPPING METHOD WITH THE CLASSICAL GOS: SELECTIVE UNDERLINING IN SUPPORTING EFL RC.

3.1 Why to Compare with SU Strategy

As KB-mapping method is a special case of SB-mapping method and there are many researchers confirmed that SB-mapping method is a very effective supporting method for EFL RC [46] [47] [39], but it is not so popular method in usual class learning. So we are trying to compare our proposed method with another supporting tool which is more common in EFL RC.

In this research we are going to compare KB-mapping method with one of the most common used strategies in the classes of EFL RC, which is the SU strategy for supporting EFL RC [5] [6].

To investigate the effects of using KB-mapping method, we designed an experiment, where KB-mapping was compared with the SU strategy for EFL RC. As known the SU is a flexible strategy that may be tailored to fit various types of information, and different skill-levels. As learners read an EFL text, SU helps them to pay attention to the essential information within the text [5] [6].

3.2 Selective Underlining (SU)

SU strategy is one of the important classroom strategies, also it is probably the most used. Generally, it is used to help learners to organize the text, which they are reading by selecting the important sentences. This strategy teaches learners to highlight/underline only the key words, phrases, vocabulary, and ideas that are central to understanding the text [5] [6]. It is very useful for comprehending the text because it is a flexible strategy that may be tailored to fit various types of information and different skill-levels. As learners study, it helps them learn to pay attention to the essential information within a text [5]. In generally this strategy is focusing on the vocabularies and comprehension of the text during the reading time, also it helps the learners to identify the important points of a text, helps them to pay close attention to what they are reading and also allow greater learning and deeper comprehension.

Typically, in the SU strategy, the learner starts by reading the text to understand the main topic of the text, after that he rereads and begins to underlining the main ideas and their supporting details, then he selects the important facts and the key vocabularies [5]. By using the underlined part of the text, the learner can give a summary for the important information in the text that he has read.

This strategy requested the learner to capture the main ideas, key concepts and details; also it helps by reducing the needed information in text, so it reduces the learning time and in the same time strength [48] the EFL RC.

3.3 KB-mapping Method

We have been developing learning tools to help both the students and the teachers in the learning process. One of these tools is KB-Map [49] [50] [51], we found that this tool is very useful for learning the sciences for the students of the mother languages [52] [53]. In this Chapter, we are trying to use this tool to support the RC of EFL learners.

3.3.1 Overview of Kit-Build Concept Map (KB-map)

KB-map is "a framework to realize automatic diagnosis of concept maps built by learners and to give feedback to their errors in the maps" [51]. KB-map is a special kind of concept map. The creation of concept map consists of two steps: the extraction of the concepts and the relations from the text and the selection of the responsible relation that connects two concepts together. In KB-mapping, the supervisor makes the first step by creating the goal map from text and after that he can generate the kit from the goal map by dividing the goal map to concepts and relations, providing learners with this kit. After that, learners are tasked to build the concept map (called learner's map) by using the concepts and the relations that provided in the kit.

While the SB-mapping and KB-mapping allow learners to organize ideas and determine the relations between them, KB-mapping does it with more controlling and redirecting of the learners; it helps evoking prior knowledge through KB-map creation. This method can be used in any discipline to help learners to make connections between ide-as, but the provided kit (all the important concepts and relations) always controls the process.

RC refers to the ability to understand information presented in a written form. KB-mapping method, as its applications, helps the learners to understand the information presented in a written form, by converting the written information into a graphical form. Such a graphical form is easily recognized and is easier to be scanned for a specific word or general idea. Moreover, it allows for a more holistic understanding of the text, but at the same time controls the process of building the learners' map by the provided kit.

The main goal of the reading task is to distinguish the important information in the text and to comprehend it. The KB-mapping method has almost the same features as the SB-mapping method but the main difference is providing the kit, which contains the important words in the text. The kit is just a list of words that supports learners to distinguish the important information from the text. In other words, giving these words with the text to the learners will not be supported, rather the supported method is to use these words to find out the important

information in the text, and this kind of activity can be implemented by using these words in building the learner's KB-map.

Finding the important information means not only to find the words, but, more importantly, means to find the relations and integrate them together to get the whole structure of the text that contains the important information (important information contains more than two important words). As it contains recognition of the relations among the words to complete the whole structure of the text, the important information cannot be found completely without thinking about the structure of the text. KB-mapping meth-od reduces the learners' load in the selection process and lets the learners focus on the structuring process.

Also, from the viewpoint of hermeneutic circle, KB-mapping method helps the learners to understand the text in a hermetical way, by building the concept map from the text, they could understand the parts (Nodes, Links) from the whole map and the whole text (KB-map) from the nodes and links. But, this method encourage the learners to comprehend the text in more deeply form by requiring him to finish all the kit to build the map. This requirement urges the learners to apply this circle for more times as the hermeneutic spiral, so the learners can get deeper understanding of the text and he could remember and recall it after a while.

3.3.2 KB-mapping System

We have already developed a system based on the KB-map explained in the previous section. This system is called as "KB-map System". It is a web application with two client systems: "KB-map Editor" and "KB-map Analyser", and a server system: "KB-map DB". KB-map Editor provides an environment for teacher, or supervisor, to make a goal map, a kit, and for learner to make a learner's map. This system has been implemented by Java (version 1.6). KB-map Analyser has functions to gather learner's maps online, generate a group map and diagnose the maps. This system has implemented by Flash and supports version Flash Player 10. KB-map DB has a function to store and share maps. This system was developed by Ruby (version 1.8.7) on Rails (version 1.2.3) and MySQL (version 5.1.30) [50].

3.3.2.1 Goal Map Editor

A teacher is required to make a goal map as an ideal result of learning with a learning material. In Goal Map Editor as shown in Figure 3-1, a part of a text of a learning material is shown in left side. A teacher makes a goal map with words in the text. In this example shown in Figure 3-1, the sentence appeared in the small window in the centre of the figure. This is a window to make a proposition from a sentence. In the window, an author of the goal map is required to pick up labels of two nodes and one link from the sentence. A proposition composed of these nodes and link is shown on the right side of Figure 3-1. Because parts of generated propositions are extracted from the same material, the meaning of the same label is guaranteed to be same. By such integration, a map is composed from several propositions that are made from the same learning material. If the teacher accepts the map as the goal map, the map is decomposed and a set of parts of the goal map is generated [51].

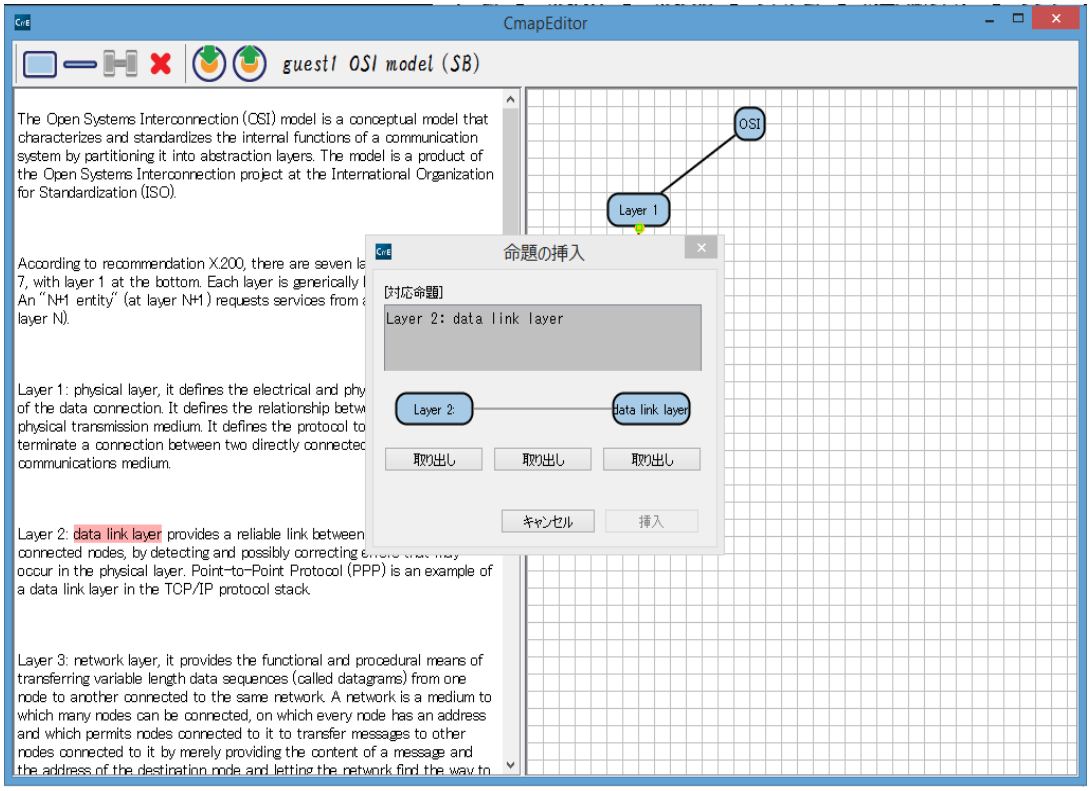


Figure 3-1. Goal Map Editor

3.3.2.2 Learner Map Builder

In Learner Map Builder, a learner firstly downloads a set of parts, that is, nodes and links. Then, the learner is required to connect them to build a map that represents his/her understanding. The connection can be carried out by drag & drop operation. When the learner pushes upload button, the map is sent to KB-map Analyzer. The learner map shown in Figure 3-2 has not completed yet because there are several nodes and links that are not connected [51].

The new version of the Learner Map Builder has functions to add concepts and relations to the learners' map so we can use it as a computerized SB-map editor in addition to the original use of creating the KB-map from the provided kit. Moreover this version uses the Point & Click functionality (the learners can select one or more words, and click on a creation mark to create a new node, link or relation) so learners can use it very simply to create an SB-map. Figure 3-1 shows the interface of the Learner Map Builder with the new functional options. This editor has six simple functions: to create a new node, a new link, and a new relation (two nodes and a link); to delete a component; to download a map from the server; and to upload a map to the server. By using these functions the learners can use this editor to build the SB-map easily.

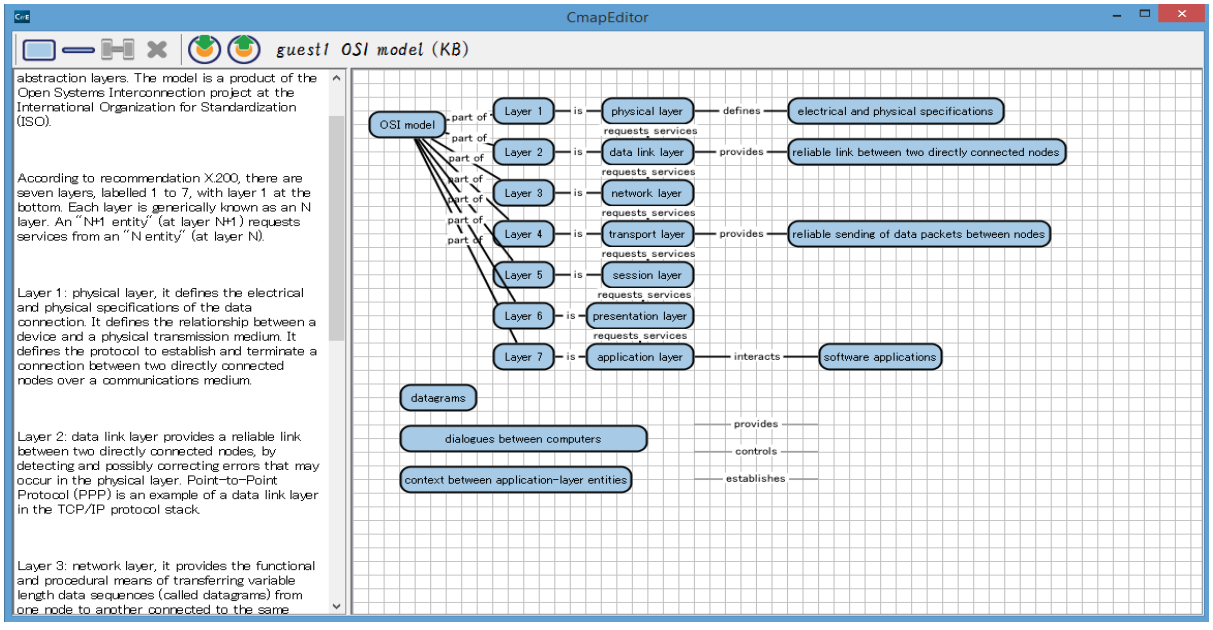


Figure 3-2. Learner Map Builder Interface

3.3.2.3 KB-map Analyzer: Learner Map

In KBmap Analyzer, learner maps are gathered and analysed. Each learner map can be observed in the same spatial placement of nodes and links that a learner made. Then, a learner map can be compared with the goal map or another learner map. In left column of Figure 3-3, a learner map and the goal map are selected as the objects of the comparison, and the result is shown in the right side. We call this map “learner-goal difference map”. The spatial placement of nodes and links in the learner-goal difference map can be adopted from either the learner map or the goal map. In this case, spatial placement of the goal map is adopted.

Coloured lines are differences between the learner map and the goal map. A lacking link is coloured blue and excessive one red. Because a leaving link is not appeared in the goal map, it is also coloured red in the same with the excessive link. In this learner-goal difference map, there are 1 excessive links, 5 lacking links and 4 leaving links. By clicking a link label, the text of the origin of the proposition that is used to make the proposition of the link (in the same way shown in Figure 7) is displayed. By using the text, it is possible to confirm the meaning of the link and the two nodes connected by the link. [51].

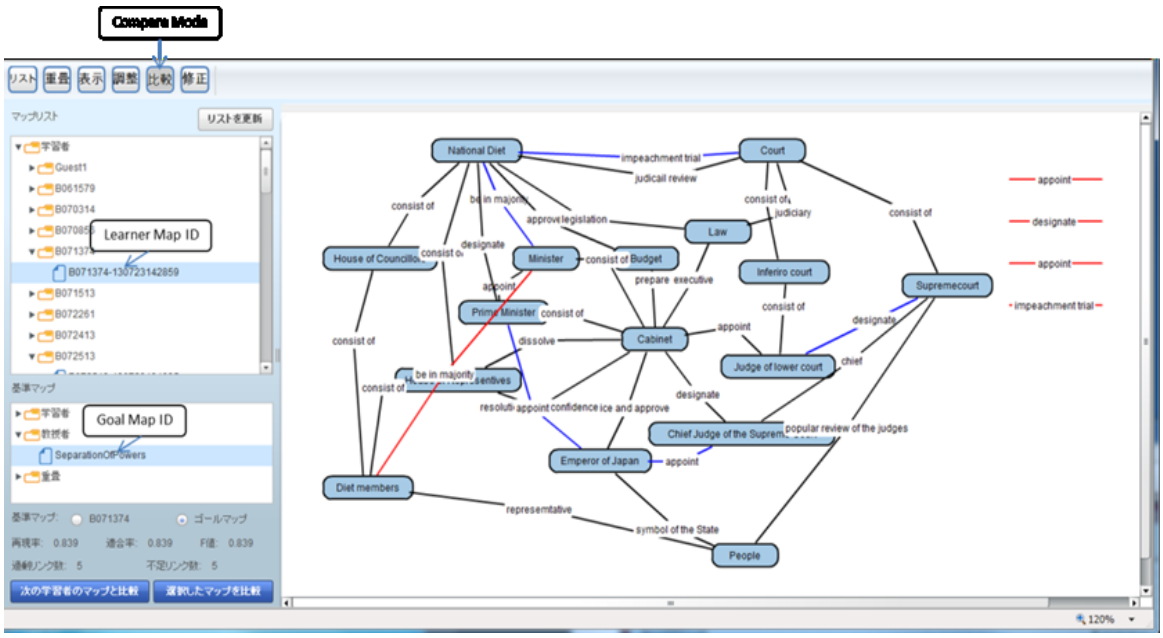


Figure 3-3. KB-map Analyzer [51]

3.3.2.4 KB-map Analyzer: Group Map

Figure 3-4 shows a group map generated by the preliminary use reported in the next section. A bold link means that many learner maps include the same connection of the link. By clicking a link label, a list of learners whose learner maps include the link is shown. By using this map, it is possible for a teacher to examine his/her learners' comprehension. However, because there are a lot of kinds of links in the group map, it is not easy to check it. Therefore, this analyzer has a function to filter links by the ratio of appearance in learner maps.

By comparing the group map and the goal map, we can find lacking and excessive links that many learners failed to correctly connect. We call this map “group-goal difference Map”. The links in the group-goal difference map can be also filtered.

These different links are basically target of additional teaching or learning. However, in the framework of kit-build concept map, we suppose that the cause of discrepancy between the goal map and learner map is not only in learner side but also in teacher side as inadequate teaching, learning material or goal map. Therefore, a teacher is also required to judge whether the different links, that is, excessive, lacking and leaving links, are acceptable or not by examining related learning material and by reflecting his/her teaching about the topics. If a link is judged acceptable one based on the current teaching or learning material, the goal map is modified to accept the link. The map including such accepted links is called “adjusted goal map”. This modification is not only a method to compensate incompleteness of the goal map but also an promising way to contribute to the improvement of the goal map, learning material and teaching itself [51].

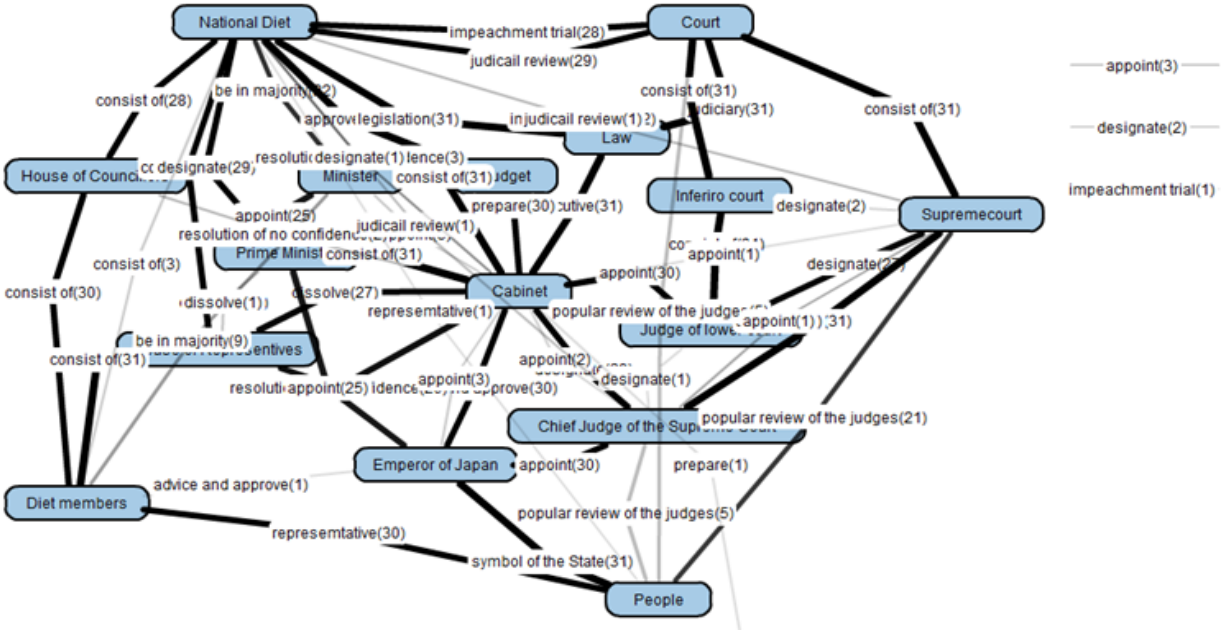


Figure 3-4. Example of Group Map [51]

3.4 Experiment Methodology

We are trying to investigate the effects of using KB-map building method as a supportive tool for the RC task by comparing them with the effects of the SU strategy from two points of view:

1. For the short term: we are measuring the understanding of the participants just after the using of our tool, and compare it with the understanding of other participants who use classical learning tool (SU) with the same conditions.

2. For the long term: we are measuring the remembered information of the participants two weeks after the using of our tool, and compare it with another participants' information who use traditional learning tool (SU) with the same conditions.

In this chapter we introduce 3 points of our experiment: the participants, the outline procedure of whole experiment and the detailed procedure of one session.

3.4.1 Participants

The subjects of this experiment were 8 Japanese students, of 3rd grade of information engineering faculty. Their scores of TOEIC exam are different from 430~625 so they have different reading abilities of English text; we prepare an aptitude test to check their abilities in the RC, this test is a simple reading test in the same level of the used in all the sessions. By using the information of their TOEIC records and aptitude test results, we grouped them into two groups A and B, which are almost commensurate with the reading ability.

We have done our experiment in 6 sessions and the two groups are changing the conditions alternately. For every participant he was three times with the KB-conditions and three times with SU-conditions.

3.4.2 Procedure of Experiment

We planned to do this experiment in six sessions as RC task for 6 different English texts; firstly we introduced to the participants the strategy of this experiment, the procedure of every session and KB-map system. For the others session we started with the delay comprehension test of the previous session, after that we did a learning activity to improve the English level of participants and in the last 30 minutes they did the session, finally we did questionnaire at the end of the last session of the experiment. During this experiment every group do it with the KB-conditions for three times and with SU-conditions three times too. We try to make balance between the different texts of this experiment.

For the last session, we had one extra time for the DCT and after doing it, we asked the learners to answer the questionnaire.

3.4.3 Procedure of One Session:

In the experimental use, we are comparing the effects of using KB-map method and the effects of SU strategy in the RC process. We are measuring these effects from two points of view, just after the using and after a while. We have designed the learning activity in this experiment in a limited period of time to avoid the effects of other supporting strategies. The process of one session, as shown in Table 3-1, consists of 4 steps:

Firstly, within 10 minutes, the both conditions groups were requested to comprehend the whole text by reading it generally and translate the difficult words in the text by using dictionary, then in the next 10 minutes the KB-conditions group was required to build the KB-map of the text by using KB-editor and in the same time the SU-conditions group was required to do the underlining of the important sentences in the text. After that both groups doing the comprehension test within 5 minutes, and finally, after two weeks both groups doing the delayed comprehension test.

Table 3-1. Procedure of One Session

Time	KB-conditions	SU-conditions
10 min	Reading the materials (using dictionary is allowed)	
10 min	Making the KB-map by using KB-editor	Underlining the important parts of the text
5 min	Comprehension test (CT)	
5 min	Delayed Comprehension test (DCT)(2 weeks after)	

3.5 Experimental Use

This experiment was done in 6 sessions with two groups of participants (A, B) both of them has almost the same reading ability. For each group they use the KB-mapping method for 3 sessions and the SU strategy for 3 sessions too.

In this practical use, computers with Intel core i3-3240 processor, 4 GB of RAM and 20″monitor were used. The used platform was windows 7. In this chapter we introduced 3 points: the preparation of the used materials, example of the real experimental use and example of the materials that used in the experiment.

3.5.1 Materials Preparation

The participants of this experiment were students of 3rd grade faculty of information engineering, so they were interested in the topics of information engineering, so firstly we selected a text from Wikipedia in the information engineering field, and checked it for the grammatical and semantically error. After that we created the corresponding KB-map (Goal

map) that covered the main concepts and relations of the text, after that we did the SU for the important and essential phrases in the text. We prepared the comprehension test. And we checked all of the material again to be sure that materials did not contain any error. Finally we checked if the answers of questions of comprehension test were covered by the KB-map and the SU to marking the questions that not covered.

3.5.2 Example of the Experimental Use

To investigate the effects of using KB-map to improve the RC of EFL, For the first session we started with a learning activity to improve the English level of student, and in the last 30 minutes we did our experiment, firstly, within ten minutes the students requested to read the text to get the main idea of it and to translate the unknown words for them by using a web dictionary. After that within 10 minutes too, the KB-conditions group tried to build the learner's map by using the KB-map editor, in the same time, the SU-conditions group were doing the SU of the important phrases of the text. In the next 5 minutes they answered the comprehension test. Finally we collected all the materials about this session (text, notes and test papers). Two weeks after, all participants did the delayed comprehension test. Table 3-1 shows the process of the first session.

For the other sessions, they did the delayed comprehension test of the previous session, as we mentioned before, and after that they started the new session as explained in the previous paragraph.

3.5.3 Example of Experimental Material

In this section, we introduce one example of the materials that was used in the first session of our experiment. Figure 3-5 shows a part of the text that was used as the original text which learners tried to comprehend it. The learners were requested to read and comprehend this text within 10 minutes, and they had the ability to use online dictionary to translate the complex and unknown words to help them in understanding the whole text.

A general purpose computer has four main components: the arithmetic logic unit (ALU), the control unit, the memory, and the input and output devices. These parts are interconnected by busses, often made of groups of wires.

Inside each of these parts are thousands to trillions of small electrical circuits which can be turned off or on by means of an electronic switch. The circuits are arranged in logic gates so that one or more of the circuits may control the state of one or more of the other circuits.

Figure 3-5. Part of the First Session's Text

A general purpose computer has four main components: the arithmetic logic unit (ALU), the control unit, the memory, and the input and output devices. These parts are interconnected by busses, often made of groups of wires.

Inside each of these parts are thousands to trillions of small electrical circuits which can be turned off or on by means of an electronic switch. The circuits are arranged in logic gates so that one or more of the circuits may control the state of one or more of the other circuits.

Figure 3-6. Example of the First Session's Underlined Text

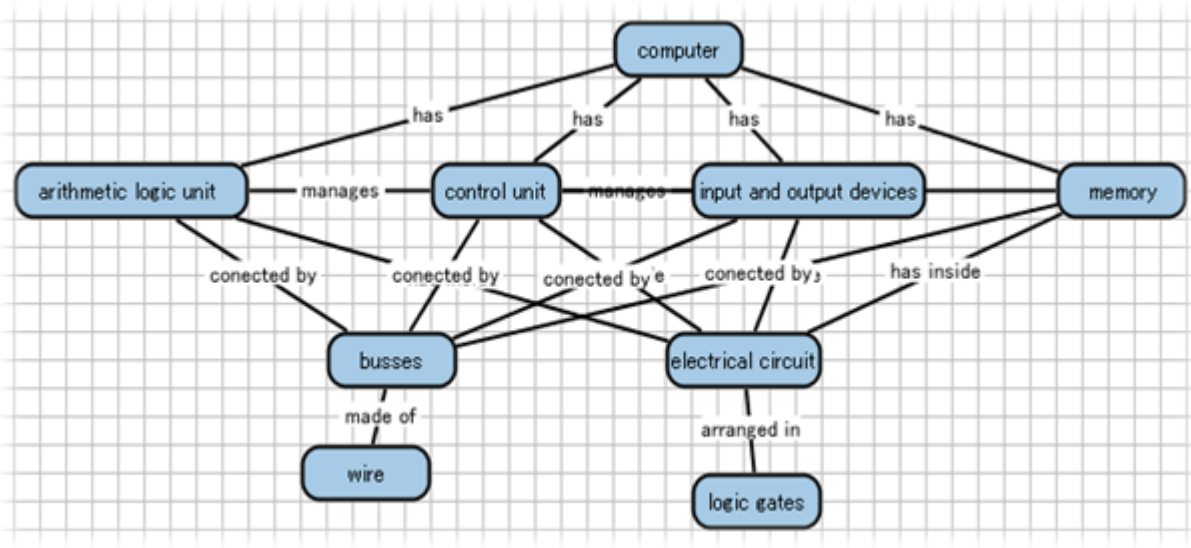


Figure 3-7. The Goal map of the Third session

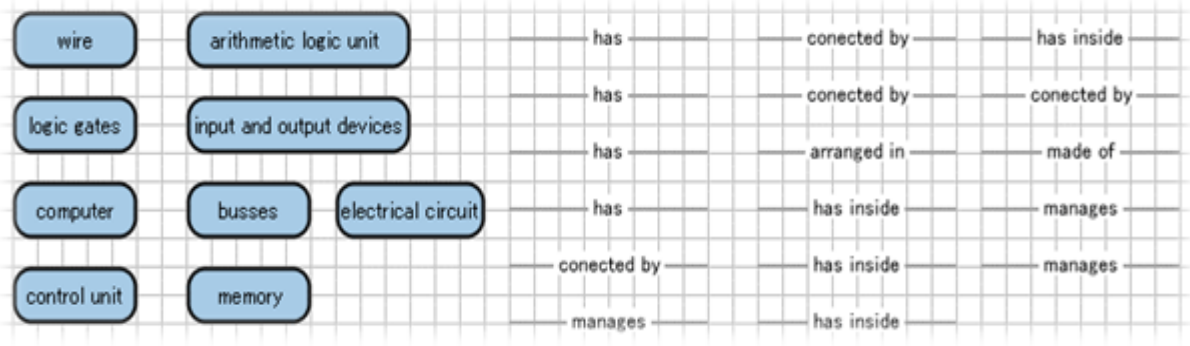


Figure 3-8. The kit of the Third session

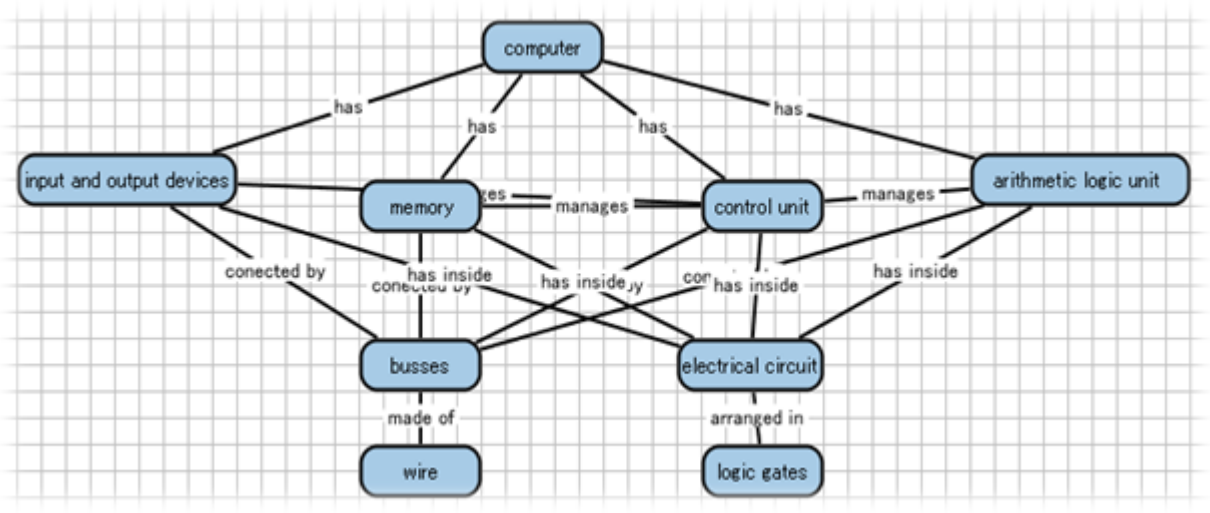


Figure 3-9. One Sample of the Learner's map of the Third session

Q3: What is the component of busses?	
a. Electrical circuits	b. Logical gates
c. Wires	d. Wires and logical gates
Q4: What are inside the control unit?	
a.Electrical circuits	b. Logical gates
c. Wires	d. Electrical circuits and logical gates

Figure 3-10. Sample of the Comprehended test of the Third session

After that, the KB-group tried to build learner's map, within 10 minutes, by using the kit that provided by the system, which generated from the corresponding goal map. Figure 3-7 shows the goal map of the text that was prepared by the supervisor. It contains most of the information of the original text, this goal map is divided by the system to generate the kit that shown in Figure 3-8. Figure 3-9 shows one example of the learner's map which was built by one of the learners.

In the same time, the SU-group tried to do the underlining for the important sentences in the text within 10 minutes too. The underlined text contains the important information of the text. Figure 3-6 shows one example of the underlining of the same paragraph.

After that all the learners did the same comprehension test within 5 minutes, which was a set of multi-choices questions scored from 100. All of these questions were asking about information included in the original text, some of them were asking about information included in the goal map and some were not, and for the underlined text all of them were included

3.6 Results

We did our experiment with 8 students in 6 sessions as shown in table 2-3, we had 6 sessions with different 6 texts, Goal maps and tests are prepared for each text. In every session we had 4 students as KB-condition group and 4 as SU-conditions group, and for the next session they were exchanging the conditions.

So we had 24 scores as KB-conditions and 24 scores as SU-conditions, by analysing these results we can show the effects of using KB-map in the learning process, which is presented in this section, also we present the results of the questionnaire that we did it in the last session.

The data of this experiment were a set of 6 sessions' results with 6 different texts, goal maps and tests. Usually this kind of results cannot be used in one parametric statistical analysis directly. Generally, the gathering of many tests results in one statistical analysis is a disapproval method, but for this situation, we planned all the sessions to be considered as one session Also, we confirmed that all the means for the session results were not different.

Table 3-2. Details of every session

Session No.	**1**	**2**	**3**	**4**	**5**	**6**
KB-Conditions	Group A	B	A	B	A	B
SU-Conditions	Group B	A	B	A	B	A
Text	T1	T2	T3	T4	T5	T6

We applied some non-parametric statistical analytical methods to check if we could use all of them together in one analysis.

3.6.1 Retaining Comprehension

By comparing the average scores of the CT and the DCT for the two conditions groups in every session, we found that the KB-group retained more information in comparing with the SU-group. Figure 3-11 shows that for every session the average difference between DCT score and CT score of the EC-group was better than the average difference of the CC-group.

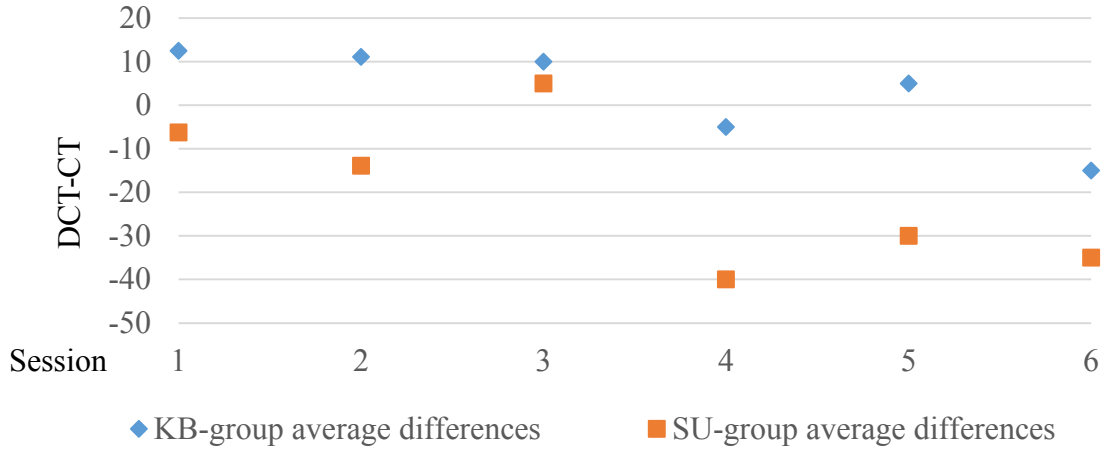


Figure 3-11. Average Differences for EC-group and CC-group

For every session we had different text, goal map and test, but for all the sessions, we had the same conditions. So, we proposed to use the differences (DCT-CT) to evaluate the recalled information for the both methods. We gathered these differences for all the 6 sessions together to have a sufficient number of results (n=24) for a valid statistical analysis. To confirm that this approach was valid, we applied some non-parametric statistical analytical methods to check if we could use all of them together in one analysis. For the KB-group differences (DCT-CT), we found by Bonferrion's method that there was no difference between any pairs of means of all session differences; for ALPHA= 0.05, the ANOVA Test (p(value)= 0.217) and with ALPHA= 0.05, the Friedman test (p(value)= 0.955) has confirmed the same result. Also we found that all the differences had similar distributions for p (chi-square distribution).

For the CC-group differences (DCT-CT), by using the same statistical analysis methods, we found, that there was no difference between any pairs of means of all session differences and all the differences had similar distributions for p (chi-square distribution).

We analysed all the differences together by using the statistical two factor ANOVA with replications. In a simple comparison of the score means, for the KB-group, we found that the average difference was +3.102, while for the SU-group, the average difference was -20.023. The differences of the KB-group were better than the differences of the SU-group for all the sessions. The value of the ANOVA Test (p(value) =0.0139< 0.05) indicated that, there were differences in the recalled information of the two groups. So we could say that the KB-mapping method helped the learners to retain their understanding for a long time. Table 3-3 shows the details of the statistical analysis.

Table 3-3. Differences for DCT-CT for two groups

DCT-CT	**KB-group**	**SU-group**
Mean	+3.102	-20.023
SD	29.184	29.984
p(value)	0.0139	

3.6.2 Detailed Analysis for Both Groups' Scores

To confirm the results of retaining information, we performed more detailed analysis of scores of both group. Figure 3-12 shows the average scores of the two conditions groups, we can notice that the KB-group could keep their comprehension after 2 weeks (the average difference is +3.1), but the SU-group could not keep their comprehension (the average difference is -20.2). Table 3-4 shows the average scores and the standard division of the two condition groups.

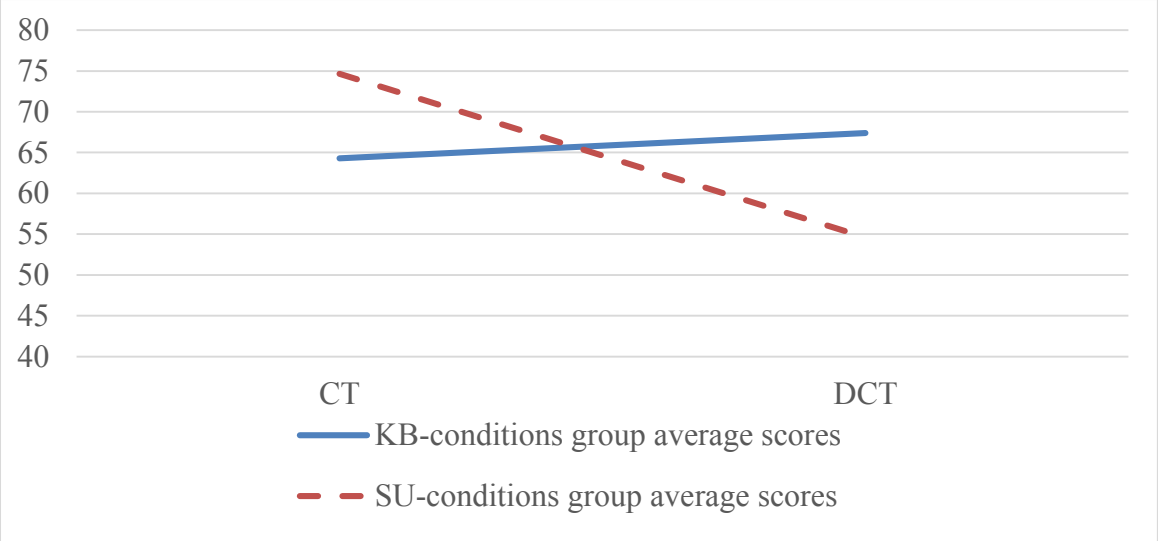


Figure 3-12. Average Scores of KB-group and SU-group

For more confirmation about these results, we did a detailed statistical analyse of our data, as introduced in this section.

By applying the statistical test "Anova: Two-Factor with Replication", on the results of this experiment, we found that for the KB-group scores of CT and DCT are almost the same (p(value) = 0.618 > 0.05), so we can say that the KB-group could keep their information. In another words, KB-mapping method helped the learners to keep their comprehension for a while (two weeks). Also for the SU-group, we found that the scores of CT and DCT are not the same (p(value) = 0.0022 < 0.05),(AV(CT)>AV(DCT)) so we can say that the SU-group could not keep their information. In another words, SU strategy did not help the learners to keep their comprehension for a while (two weeks). Table 3-4 show the average scores, Standard division of the both condition groups.

Table 3-4. The both Groups' average Scores (SD)

	CT	DCT
KB-group	64.28 (26.24)	67.38 (21.49)
SU-group	74.63 (18.34)	54.60 (23.85)

For the CT scores, we found that the CT scores of the two condition groups are almost the same (p(value) = 0.1252 > 0.05), so we can say that the two conditions groups could comprehend the texts. In other words, KB-mapping method was effective as the SU strategy to understanding the texts.

Also, for the DCT scores, we found that the DCT scores of the two condition groups are not the same (p(value) = 0.043 < 0.05),(AV(KB-group)>AV(SU-group)), so we can say that the two conditions groups could not retaining the texts in the same level, in another way, KB-mapping method was more effective than SU strategy to recall the comprehended information.

In this experiment, the two groups of subjects are balanced by their TOEIC scores and aptitude test scores, both groups had followed KB-conditions for three times and SU conditions for three times too. The process of KB-conditions and SU-conditions were same in all phrases except the phrase of building learner's map and doing the SU for the text, which had the same time to do. We analyzed the data by using win-lose-tie statistical analyze to show which is better among the CT, DCT and the difference (Diff=DCT-CT). Table 3-5 is the summary of the win-lose data.

Table 3-5. Win-lose table and binominal test of the KB-conditions scores

Session No.	**1**	**2**	**3**	**4**	**5**	**6**	**∑**	***P*(value)**
CT	1	0	1	0	0	0	2	0.234
DCT	1	0	1	1	1	1	5	0.094
Diff	1	1	1	1	1	1	6	0.016

To evaluate the results of the win-lose-tie table, we used the binominal test to calculate the probability mass function of the number of KB-mapping method winnings in all the sessions. By using the binominal test, We found that the KB-conditions won in the CT for 2 of six sessions (2 wins +4 lose); the probability that there were two successes in six trials was (p (2/6)=0.234>0.05). This result indicated that the KB-mapping method did not show better

effects in the CT just after being used. For the DCT, we found that the KB-conditions won in five of six sessions (6 wins); the probability that there were 5 successes in six trials was ($p(5/6)= 0.094>0.05$); This was slightly significantly different ($p<0.10$); this result indicated that the KB-mapping method showed better effects in the DCT two weeks after being used. Also for the differences (DCT-CT), we found that the KB-conditions won in six of six sessions (six wins), and the probability that there were six successes was ($p(6/6)= 0.016<0.05$); this probability was significantly different. This result indicated that the KB-mapping method had better effects on recalling the comprehended information 2 weeks after being used.

3.6.3 Effects of Using KB-mapping Method in CT&DCT

To investigate the effects of using KB-mapping method, we did more detailed analysis about the included questions in learner's map of our experiment.

The included questions were the questions that can be answered by using the learner's map, as examples, in Figure 3-10 the questions 3 and 4 are included questions in the learner's map that shown in Figure 3-9, they could be answered by using the components of the learner's map.

For the CT, we calculating the score of the included questions, that their answers were correct, in the learner's map and comparing them with the total number of the included questions in the learner's map. We found that the KB-group learners could answer 76% of the questions that their answers are included in their learner's maps.

$$\mathrm{Av}\left(\frac{\text{correct answer in comprehension test included}}{\text{included questions in learner's map}}\right) * 100 = 75.625$$

Equation 3-1. Included Correct answered questions in CT

In equation 1, we calculated the number of the correct answered questions in the CT, which their answers are included in the learner's map and compared them with the total number of questions, which their answers are included in the learner's map, finally we calculate the average.

For the DCT, we calculating the score of the included questions in the learner's map and comparing them with the total number of the included questions. We found that the EC-group learners could remember 86% of the questions that their answers are included in their learner's maps.

$$\mathrm{Av}\left(\frac{\text{correct answer in delayed comprehension test included}}{\text{included questions in learner's map}}\right) * 100 = 85.625$$

Equation 3-2. Included correct answered questions in DCT

In equation 2, we calculate the number of the correct answered questions in the DCT, which their answers are included in the learner's map and compare them with the total number of questions which their answers are included in the learner's map, finally we calculate the average.

From the equations 1&2, we can say that the using of KB-Mapping method helped the learners to use and recall, after two weeks, most of the information that was included in their learner's map.

3.6.4 Effects of Text Without KB-map in CT&DCT

To make more confirmation about the effects of using KB-mapping method, by checking the effects of the other parts of the text that not included in the learner's map, we did more detailed analysing about the "not included questions in learner's map" of our experiment.

The not included questions were the questions that cannot be answered by using the learner's map, as examples, in Figure 3-10 the questions 5 is not included questions in the learner's map that shown in Figure 3-9, they could not be answered by using the components of the learner's map.

For the CT, we calculating the score of the not included questions, that their answers were correct, in the learner's map and comparing them with the total number of the not included questions. We found that the SB-group learners could answer only 45% of the questions that are not included in their learner's maps.

$$\mathrm{AV}\left(\frac{\mathit{C}\text{orrect }\mathit{A}\text{nswer in }\mathit{C}\text{omprehension }\mathit{T}\text{est not }\mathit{I}\text{ncluded}}{\text{not }\mathit{I}\text{ncluded }\mathit{Q}\text{uestions in }\mathit{L}\text{earner's }\mathit{M}\text{ap}}\right) * 100 = 45.069$$

Equation 3-3. Not included correct answered questions in CT

In equation 3, we calculate the number of the correct answered questions in the CT which their answers are not included in the learner's map and compare them with the total number of questions which their answers are not included in the learner's map", finally we calculate the average.

For the DCT, we calculating the score of the not included questions in the learner's map and comparing them with the total number of the not included question. We found that the EC-group learners could remember only 42% of the questions that are not included in their learner's maps.

$$\mathrm{AV}\left(\frac{\mathit{C}\text{orrect }\mathit{A}\text{nswer in Delayed }\mathit{C}\text{omprehension Test not }\mathit{I}\text{ncluded}}{\text{not }\mathit{I}\text{ncluded }\mathit{Q}\text{uestions in }\mathit{L}\text{earner's }\mathit{M}\text{ap}}\right) * 100 = 42.0139$$

Equation 3-4. Not included correct answered questions in DCT

In equation 4, we calculate the number of the correct answered questions in the DCT which their answers are not included in the learner's map and compare them with the total number of questions which their answers are not included in the learner's map, finally we calculate the average.

From the equations 3&4, we can say that the effects of the text without KB-mapping method was not so helpful for the learners to answer or to remember the information that not included in their learner's maps.

As a summarization for section 5.3 and 5.4, we found that if the learner could build a good learner's map, he would get a good score in the CT and he would get a good score in the DCT. In other words, the learner's map could be used to evaluate the learner's comprehension.

3.6.5 Questionnaire

After we finished the last session DCT, the learners answered the questionnaire to evaluate the learning method of using KB-mapping method and compare it with the SU strategy. Table3-6 show the results of this questionnaire.

The questions (1-6&9) were 5 choices questions, that measure the participants agreement with the mentioned point by the question. The choices that used are (A. Strongly agree, B. Agree, C. Natural, D. Disagree and E. Strongly Disagree), and the questions (7&8) were 3 choices questions, that compare between the two learning methods. The choices that used are (A. Underlining, B. Same, C. Map Building); to normalize the results of this questionnaire, we tried to summarize all the results of our questionnaire and convert them to un arithmetical form that means (1 Strongly agree, 0.5 Agree, 0 Natural, -0.5 %Disagree, and -1 strongly Disagree) and in the same time it is means (1 Map building, 0 same and -1 underlining). As a summarization of the questionnaire evaluation, 0 means the normal, the positive means agreement and the negative means disagree and the value shows the strength of the agreement or the disagreement.

From questions (1&4&7)(2&5)(3&6),the learners thought that the KB-mapping method was useful to understand English text as the SU strategy and also useful to answer the CT just after the learning activity, but they thought that KB-mapping method more useful to answer the DCT two weeks after, Also from questions (8,9) they thought that the KB-mapping method was more difficult to carry out, but they liked to use KB-mapping method in RC task but they need more time to do it.

Table 3-6. Evaluation of KB-mapping method for EFL RC by comparing with SU strategy

Explanation	Agree
Q1. Do you think that selective underlining strategy was useful to understand English text?	0.1875
Q2. Do you think that selective underlining strategy was useful to answer the test after reading?	0.1875
Q3. Do you think that selective underlining strategy was useful to answer test two week later?	-0.375
Q4. Do you think that KB-mapping method was useful to understand English text?	0.5

Q5. Do you think that KB-mapping method was useful to answer the test after reading?	0.375
Q6. Do you think that KB-mapping method was useful to answer test two week later?	0.125
Q7. Do you think that KB-mapping method was more useful to understand English text?	0.625
Q8. Do you think that KB-mapping method was more difficult to carry out?	0.75
Q9. Did you like to use KB-mapping method to understand English text?	0.0625

3.7 Consideration

We found that the KB-mapping method user could retain the knowledge as the underlined method users, but they are more effective in the recalling. This result is harmonized with principle of structured storing of knowledge in memory, which proposed by cognitive psychology research. It has shown that the knowledge in the memory is stored in a structured form that determines the ability to retain, recall and use it to solve problems [54] [55] [56]. For KB-mapping method, the learner tried to build the KB-map, which is a structured form of the knowledge, by using the provided information from the original text.

Cognitive psychology has shown that the way knowledge is structured in the memory that determines the ability to retain, recall and use it to solve problems [54], for our KB-mapping method, the learner try to build the KB-map, which is a structured form of the knowledge, by using the provided information from the original text, so we found that the KB-mapping method user could retain the knowledge as the underlined method users but they are more effective in the recalling.

In generally, the using of KB-mapping method need a concentration in reading the text and needs to read with attention to distinguish the two concepts that can be related and to find the corresponding relation that can connect them together, in the same time, this process required the learner to understand the information in the text deeply and required him to comprehend the text in whole. So we can explain our result by the required high load on the learner memory to comprehend deeply the whole text to complete the learner's map, this load force the learner's memory to keep most of the information, that he has already comprehend.

When constructing a KB-map, the focus is on the relationships among concepts because the learner does not required to think about the distinguishing of the concepts that are already provided by the system so his entire constraining is on the understanding of the whole text.

4 COMPARING WITH ADVANCE METHOD: SCRATCH CONCEPT MAPPING METHOD IN SUPPORTING EFL R.C.

4.1 Why to Compare with SB-mapping Method

In language learning contexts, RC is an important learning activity that requires a special ability from the learner to reap its benefits [57]. RC poses many challenges since learners may experience such issues as slow reading, insufficient vocabulary comprehension and poor recalling [58]. Researchers have always tried to support this learning activity by proposing various methods or strategies [6] [46] [59] [47]. The main goal is to boost comprehension skills in the target subject area. When researches are deployed in a language course, the main aims are to improve student RC of the text and to contribute to the acquisition of the Target Language [60].

Our previously conducted experiments in the ML [49] [51] [53] showed that the KB-mapping method has good effects for performing tasks that require a high cognitive load, as an example learning science in elementary school [53], and that require memory retention [49]. In the latter study, we showed that the KB-mapping method has the same level of memory retention as the Scratch Concept mapping (SB-mapping) method. Also in previously conducted experiments in EFL [61] [62], we showed that the KB-mapping method is good as the SU strategy just after use, but it has a better effect in recalling after some time has passed.

In the present research, we tried to investigate the effects of using KB-mapping in comprehending English text and recalling it after two weeks. We conducted an experiment to confirm the efficiency of the KB-mapping method in the learning tasks that require a high cognitive load such as EFL RC. We designed an experiment to compare SB-mapping for RC with our KB-mapping method. SB-mapping is a flexible method that may be tailored to fit various types of information, and different skill levels. Also SB-mapping is an advanced and popular method to help learners in raising their RC [39].

4.1.1 Purpose of This Experiment:

We have been developing learning tools to help both students and teachers in the learning process. One of these tools is the KB-map, which is a special kind of SB-map and, we have conformed its high efficiency in many fields of learning such as RC of EFL students [61]; moreover, it has effects in the remembering and recalling of the comprehended text after some time has passed [49] [51] [53] [62]. Also we found it was very useful for learning sciences by students in their ML [52]. Moreover, some of our studies suggested that KB-mapping is a promising tool to estimate learners' understanding in classrooms by using diagnosis and feedback with the KB-map [49] [53].It has good effects for the teachers and students.

In our previous research we found that the KB-mapping method has almost the same efficiency as SB-mapping method for a simple reading task in ML, also we found that it provides good support for performing tasks that require a high cognitive load. As we explained before EFL RC exerts a bigger cognitive load to learners than ML RC does. So in this research we assumed that the KB-mapping method has some advantages in supporting learners' performance in EFL RC in comparison with SB-mapping method.

The task to build a SB-map can be divided into two sub-tasks: 1) the "segmentation task" in which it is necessary to pick out the important words in the text and find the relations between them (i.e., to find every part of the important information); and 2) the "structuring task" in which the extracted parts are integrated into a map [50]. From this viewpoint, in the closed-end approach, for the task of building the KB-map: the picking out part is replaced by providing a kit (all the important concepts and relations), and the finding the relations part is replaced by

the recognition task of the parts; finally, the structuring task is the same for both mapping methods. Therefore, learners are relieved of the burden of the selection and they are able to concentrate on the structuring task. Moreover, if learners fail to pick out necessary concepts and relations, it is impossible for them to recover from the failure. Based on these considerations, we felt that reducing the load of learners in the selection process and letting learners focus on the structuring process are promising ways to improve their comprehension.

SB-mapping is a very effective method to support the EFL students' RC task, and it is effective for comprehending and recalling the text. As we mentioned before the KB-map is a special kind of SB-map, and in this research, we are trying to use the KB-mapping method to support the RC of EFL students, and to compare it with the SB-mapping method to confirm the efficiency of KB-mapping in the comprehension and recalling of English text.

4.2 Scratch Build Concept Mapping Method

SB-mapping Method is one of the newest strategies used to support the RC learning task, and it gives good effects on RC of EFL learners [47] [46]. SB-maps are visual representations of the knowledge which can be employed as a learning strategy by the learners to find the relationship between current knowledge and new information [63]. Researches have confirmed that EFL learners who used concept mapping gained high understanding in RC. Also, many studies proved that the concept mapping or semantic mapping technique could improve the learners' RC because they could understand the text more easily through the concept map.

SB-mapping provides learners with opportunities to become actively involved in their learning while linking knowledge to the long-term memory. Through the use of concept maps, learners have opportunities to organize their thoughts in a concrete and/or graphic/visual format, while connecting concepts and linking prior knowledge to new knowledge [46]. Accordingly, related concepts become connected rather than being fragmented. Concept maps also provide learners with opportunities to reconsider their own thinking, as they reflect on their conceptual understandings. The process of map drawing has a positive impact on learners' awareness of the reading process and learners can have more control over RC in English by visually representing what is conveyed in the texts they read.

In the practical use of SB-mapping method in our previous experiments, we noticed that the low reading ability learners were parsing the text sentence-by-sentence to ex-tract the concepts and the relation in order to add them to the learner's map. This style of building is similar to the sentence-by-sentence comprehension style. Also the results of our previous researches indicate that the learners with SB-mapping method had the similar tendency as sentence-by-sentence comprehension understanding, so in this research, we investigated the effects of SB-mapping method during the building process in avoiding the sentence-by-sentence comprehension.

In general, using the SB-mapping method has many ad-vantages in the RC process, such as it helps learners brainstorm and generate new ideas. Moreover, it encourages learners to discover new concepts and the propositions that connect them, allows learners to connect ideas, thoughts and information more clearly, and enables learners to gain enhanced knowledge of any topic and evaluate the information. All of these advantages improve the learners' comprehension of the text and allow them to recall the comprehended information after a while.

From the viewpoint of hermeneutic circle, SB-mapping method helps the learners to understand the text in a hermetical way, by building the concept map from the text, they could understand the whole text (concept map) from the text by creating the concept map from selecting the concepts and relations from the text.

4.3 Experiment Methodology

For the experiment, the method of investigation is very complicated and the requirements of every session are not easily applied for a big number of participants, so we planned to do this experiment with a small number of participants in several sessions. In the experiment, we were trying to investigate the effects of using the KB-mapping method as a supportive tool for the RC task, by comparing them with the effects of using the SB-mapping method from two viewpoints: The short-term viewpoint: we measure the understanding of the participants just after using the two methods, and compare them together. The long-term viewpoint: we measure the recalled information of the learners two weeks after using the two methods, and compare them together.

In this section, we describe the subjects, outline the procedure for the whole experiment, and give the detailed procedure of one session.

4.3.1 Participants

The participants were 11 Japanese students in the 3rd year of the information engineering course. Their TOEIC exam scores ranged from 390 to 730, so they had different reading abilities for English texts. We prepared an aptitude test to check the learners' abilities in RC and to check if the level of text used was suitable for this experiment. This test was a simple reading task with a text, which was generated in the same way in all the sessions, and consisted of 10 multiple choices questions. By using their TOEIC scores, TOEIC reading scores and aptitude test scores, we grouped the participants into two groups, A and B, which had almost the same average scores. Table 1 shows the average scores of the two groups.

Table 4-1. The Average Scores for Groups A and B

	TOEIC Score	Aptitude Test	TOEIC Reading Score
Group A	495	46	176
Group B	496.7	46.7	185.8

4.3.2 Procedure of the Whole Experiment

The experiment was done in 6 sessions of the RC task for 6 different English texts. First, we introduced learners to the methodology of this learning process, the procedure of every session and the KB-map system. For the last 5 sessions, we started with the delayed comprehension test (DCT) of the previous session. For the DCT of the sixth session, we did it two weeks after the session. After that, we did a questionnaire. During this experiment, groups A and B each underwent Kit Build conditions (KB-conditions) 3 times and Scratch Concept map conditions (SB-conditions) 3 times. The conditions were alternated and the KB-conditions group was considered to be the KB-group and the SB-conditions group was considered to be the SU-group. We tried to keep a balance between the different sessions regarding the texts, goal maps, and tests. We explain this later in Section 4.4.1.

In this experiment, the learners with SB-conditions had to find out the important information in the text; the time of segmentation and structuring was almost the same as the time needed for the recognition and structuring of KB-map building. Also they could create the node and links by a very easy and fast way because of the new function Point & Click of the KB-editor (they only had to mark a part of the text and click on the creation button to create a node or link). And the connecting time was the same for both of them.

But in practical use, the SB-conditions learners had to parse the text sentence by sentence to extract the concepts and to connect them with the relevant relationship at the same time.

In the experiment all the learners could create the learner's KB-maps from the kit for 3 sessions and build the learner's SB-map from the text for the other 3 sessions. Both groups had comprehended the text by using the two methods based on their CT scores. All the learners could extract appropriate concepts and build proper maps without the concepts extracted from the goal maps.

4.3.3 Procedure of One Session

In the experiment, we compared the effects of using the KB-mapping method and the SB-mapping method in the RC process. We measured these effects over two stages: just after the use and after some time had passed. We designed the learning activity to be done in a limited period of time to avoid the effects of other supporting strategies. The process of one session, as shown in Figure 2, consisted of four steps. In the first 10 min, both groups were requested to read the whole text by skimming it (translating the difficult words in the text using a dictionary was allowed). Then, in the next 20 min, the KB-conditions group was required to build the learner's KB-map of the text by using the Learner Map Builder, and in the same time the SB-conditions group was required to build the SB-map of the text by using Learner Map Builder too. Within the building time, the learners can read the text to check their comprehension. After that both groups did the comprehension test (CT) within 5 min to measure their comprehension of the text. Finally, after 2 weeks both groups did the same CT again as a DCT to measure their recallable information.

Table 4-2. The Procedure of One Session

Time	KB-conditions	SB-conditions
10 min	Reading the materials (using a dictionary was allowed)	
20 min	Making the KB-map by using KB-editor	Making the SB-map by using KB-editor
5 min	Comprehension Test (CT)	
5 min	Delayed Comprehension Test (DCT) (2 weeks later)	

4.4 Experimental Materials

In this section, we introduce two points: the preparation of the materials used and examples of them materials.

4.4.1 Preparation of Materials

First we selected 6 intermediate level texts in the information engineering field to be used as materials. The participants were all students in the faculty of information engineering, so they were considered to be familiar with the topics. The texts were of the same size (word count), and taken from Wikipedia; we checked them for grammatical and semantical errors. After that, we created the corresponding KB-map (goal map) for every text, by using the Goal Map Editor. The goal map covered the main concepts and relations; and all of the goal maps had almost the same size and structure. We prepared the CTs, which were multiple choice tests with 10 questions of the same level of complexity, 80% of the comprehension questions could be answered by the goal map and the others could not. Again we checked all of the materials to be sure they did not contain any errors. Finally, we noted if the answers to questions of the CT were covered by the goal map and we marked the questions that were not covered; these were used for a detailed analysis.

4.4.2 Example of Materials

In this section, we introduce one example of the materials used in the third session of our experiment. First, the learners logged into the Learner Map Builder by using their private

accounts. After that, they were requested to download the materials of the session. The KB-conditions group downloaded the text and the kit; the SC conditions group downloaded the text only.

Figure 4-2 shows a part of the text that was used as the original text which learners tried to comprehend it. The participants were requested to read and comprehend this text roughly within 10 min. They could use an online dictionary to translate complex or unknown words to help them in understanding the whole text.

> A language is typed if the specification of every operation defines types of data to which the operation is applicable, with the implication that it is not applicable to other types. In most programming languages, dividing a number by a string has no meaning. Most modern programming languages will therefore reject any program attempting to per-form such an operation. In some languages, the meaning-less operation will be detected when the program is com-piled ("static" type checking), and rejected by the compiler, while in others, it will be detected when the program is run ("dynamic" type checking), resulting in a runtime exception.

Figure 4-1. Sample of the text in third session

After that, the KB-conditions group tried to build the learner's KB-map, within 20 min, by using the kit that was provided by the system which generated it from the corresponding goal map. The goal map was prepared by the teacher beforehand by using the Goal Map Editor. Figure 4-3 shows the corresponding goal map of the text shown in Figure 4-2. It contains most of the information of the original text; this goal map was divided by the system to generate the kit shown in Figure 5. The SB-conditions group, on the other hand, tried to build the learner's SB-map within 20 min, using Learner Map Builder too. After the learners finished the building of the learner's maps they were requested to upload them to the server application (KB-map DB) by using the uploading function of Learner Map Builder. KB-map DB stored all the learners' maps (KB-maps and SB-map) for later analysis.

After completing their maps, all the participants did the same CT within 5. All of these multiple choice questions asked about information included in the original text, some of them were included in the goal map and some were not. On completing the CT, they finished the day's session. They did the CT again as a DCT two weeks later.

Figure 4-5 shows one example of an actual learner's KB-map and Figure 4-6 shows one example of an actual learner's SB-map for the same written text. Figure 4-7 shows part of the CT test for the third session.

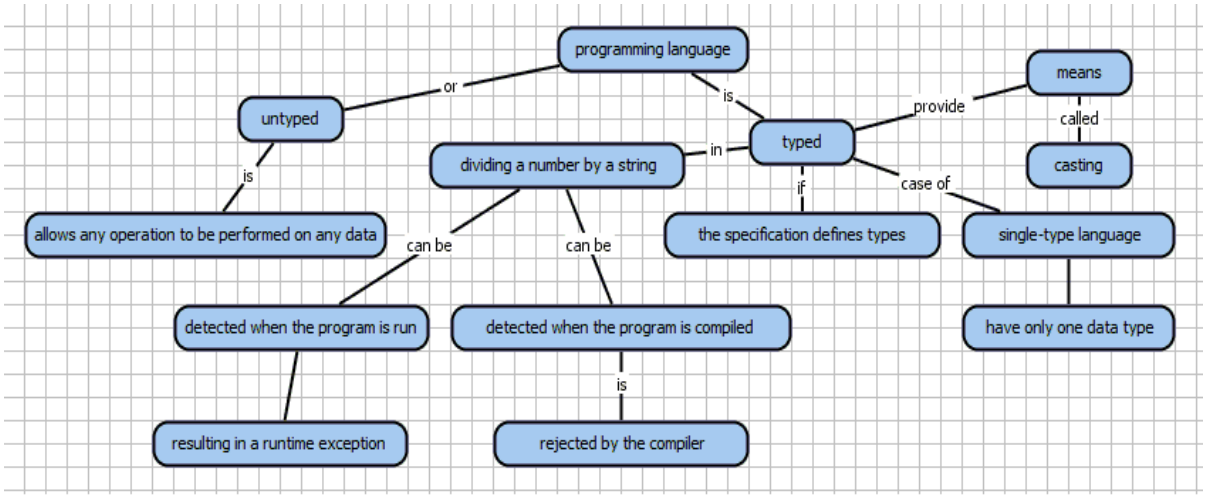


Figure 4-2. The Goal map of the Third session

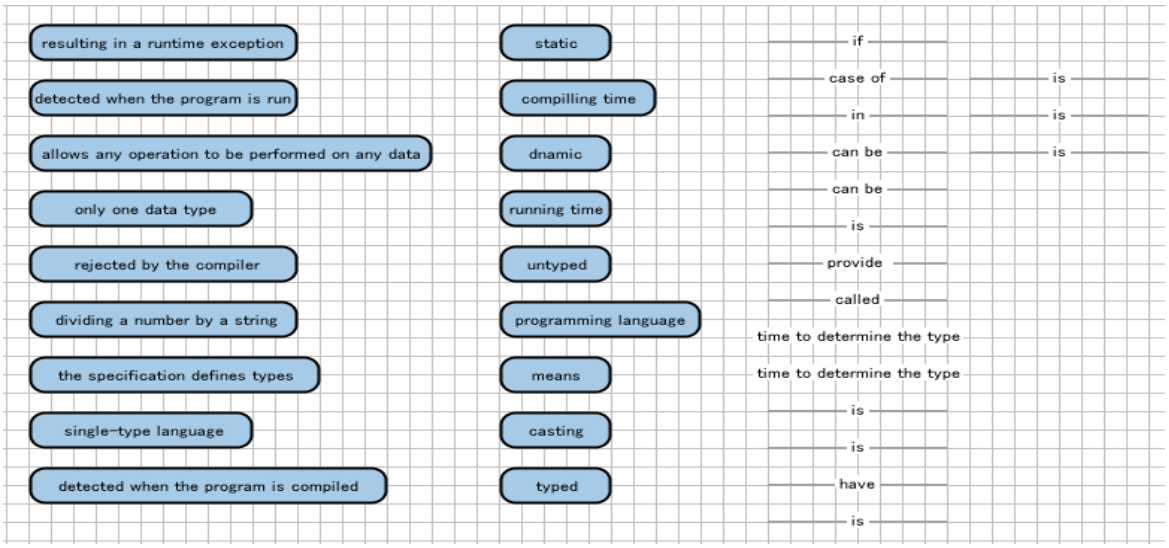


Figure 4-3. Kit of third session

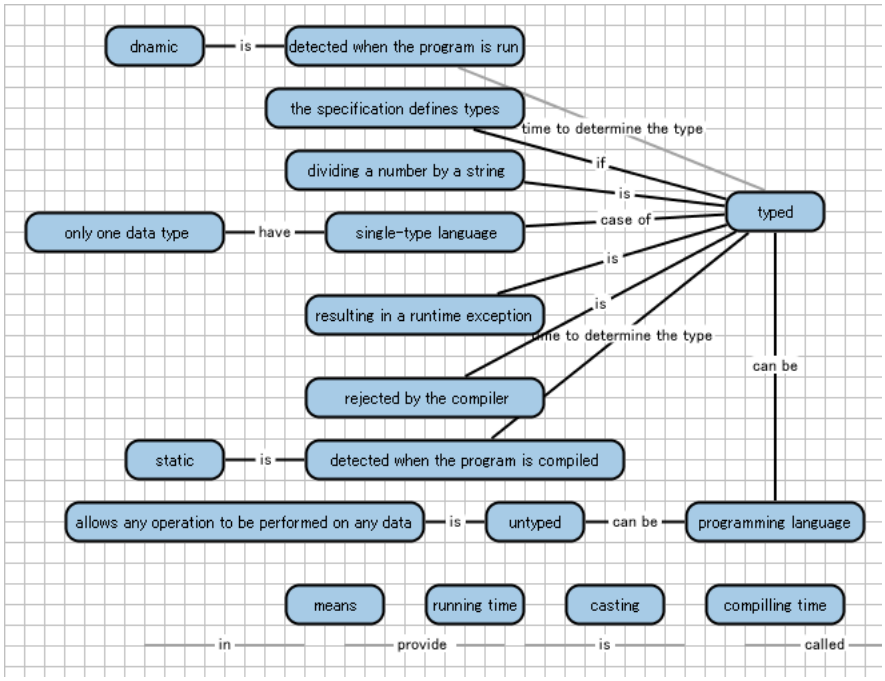


Figure 4-4. Example of the learner's KB-map of the third session

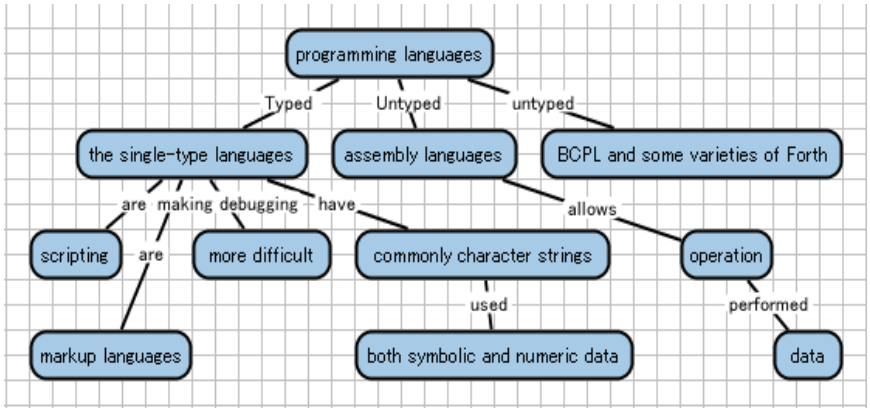


Figure 4-5. Example of the learner's SB-map of the third session

Q2: With typed languages, if the error of types of data is not discovered in compiling can we discover it later?

a. can b. cannot

c. can with conditions d. I don't know

Q3: In untyped languages can we do an operation with two types of data?

a. can b. cannot

c. can with conditions	d. I don't know
Q4: With untyped languages, if the error of types of data is not discovered in compiling can we discover it later?	
a. can	b. cannot
c. can with conditions	d. I don't know

Figure 4-6. Example questions from the third session CT

4.5 Results

We performed our experiment with 11 students in 6 sessions. In 3 sessions we had 5 participants as the KB-conditions group (Group A) and 6 as the SB-conditions group (Group B), then the participants were shifted to the alternate conditions groups and we had 6 participants as the KB-conditions group and 5 as the SB-conditions group. The two groups of participants alternated the conditions after every session. So, we had 6 sessions with different 6 texts, goal maps and tests, but for all the sessions participants were balanced. Table 4-3 shows participant details for every session, the text used, the corresponding goal map and the test which used as CT and DCT.

For every session, we compared the CT average scores, the DCT average scores and the differences (DCT-CT) for the two conditions group. We found that the KB-group had a better CT average score in 4 sessions and nearly the same average in the remaining 4. For the DCT and the difference DCT-CT (Diff) we found that the KB-group has a higher average in all the sessions. Table 4-4 shows the average scores of CT, DCT and (Diff) in every session for the two conditions group and the average scores for all sessions together.

Table 4-3. Details of every session

Session No.	**1**	**2**	**3**	**4**	**5**	**6**
KB-conditions	A	B	A	B	A	B
SB-conditions	B	A	B	A	B	A
Text	T1	T2	T3	T4	T5	T6
Goal map	G1	G2	G3	G4	G5	G6

Test	S1	S2	S3	S4	S5	S6

The data of this experiment were a set of 6 sessions' results with 6 different texts, goal maps and tests. Usually this kind of results cannot be used in one parametric statistical analysis directly. Generally, the gathering of many tests results in one statistical analysis is a disapproval method, but for this situation, we planned all the sessions to be considered as one session as is explained in section 4.4.1. Also, we confirmed that all the means for the session results were not different.

First, we tried to use the non-parametric analysis (win-lose-tie) to check which method is better. In doing so, by using Table 4-4, we calculated the win-lose-tie table for the KB-group scores of all the sessions for the CT, DCT and Diff.

Table 4-4. Win-lose-tie Table and Binominal Test of the KB-conditions Group Scores

Session No.	1	2	3	4	5	6	∑	P(value)
CT	1	1	1	1	0.5	0.5	5	0.094
DCT	1	1	1	1	1	1	6	0.016
Diff	1	1	1	1	1	1	6	0.016

To evaluate the results of the win-lose-tie table, we used the binominal test to calculate the probability mass function of the number of KB-mapping method winnings in all the sessions. By using the binominal test, we were looking for significance at the 5% level. We found that the KB-group won in the CT for 5 of 6 sessions (4 wins +2 ties); the probability that there were 5 successes was ($p(5/6)=0.094>0.05$). This result indicated that the KB-mapping method did not show better effects in the CT just after being used. For the DCT, we found that the KB-group won in 6 of 6 sessions (6 wins); the probability that there were 6 successes was ($p(6/6)= 0.016<0.05$); This probability was significantly different; this result indicated that the KB-mapping method showed better effects in the DCT 2 weeks after being used. Also for the

differences (DCT-CT), we found that the KB-group won in 6 of 6 sessions (6 wins), and the probability that there were 6 successes was ($p(6/6)= 0.016<0.05$); this probability was significantly different. This result indicated that the KB-mapping method had better effects on recalling the comprehended information 2 weeks after being used.

4.5.1 Retaining Comprehension

By comparing the average scores of the CT and the DCT for the two conditions groups in every session, we found that the KB-conditions group (KB-group) retained more information in comparison with the SU-conditions group (SB-group). Figure 4-8 shows that for every session the average difference between DCT score and CT score of the KB-group was smaller than the average difference of the SB-group. Also from Table 3 we could confirm this result as the KB-group won in 6 sessions.

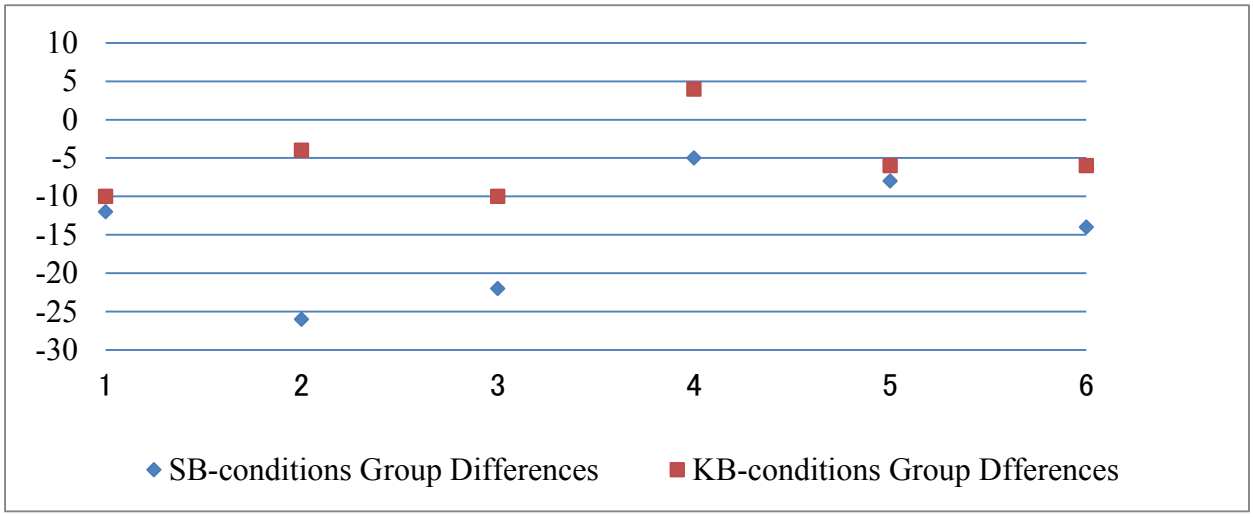


Figure 4-7. Average differences of KB-conditions group and SB-conditions group for each session

For every session we had different texts, goal maps and tests, but for all the sessions, we had the same conditions. So, we proposed to use the differences (DCT -CT) to evaluate the recalled information for the both methods. We gathered these differences for all the 6 sessions together to have a sufficient number of results for a valid statistical analysis. To confirm this approach was valid, we applied some non-parametric statistical analytical methods to check if we could

use all of them together in one analysis. For the KB-group differences between the DCT and the CT scores (DCT-CT), we found by Bonferrion's method that there was no difference between any pairs of means of all session differences; and for ALPHA= 0.05, the ANOVA Test gave p(value)=0.556. Also with ALPHA= 0.05, the Friedman test gave p(value)= 12.945% and the Kruskal-Wallis test gave p(value)=8.62%. We found that all the differences had similar distributions for p (chi-square distribution). Also for the CS-group differences (DCT-CT), by using the same statistical analysis methods, we found, that there was no difference between any pairs of means of all session differences and all the differences had similar distributions for p (chi-square distribution).

We analysed all the differences together by using the statistical two factor ANOVA with replications. In a simple comparison of the score means, for the KB-group, we found that the average difference between the DCT and the CT was -6.129, while for the SB-group, the average difference between the DCT and the CT was -14.194. The differences of the KB-group were better than the differences of the SB-group for all the sessions. The value of the ANOVA Test (p(value) =0.022< 0.05) indicated that, there were differences in the recalled information of the two groups. So we could say that the KB-mapping method helped the learners to retain their understanding for a long time. Table 4-5 shows the details of the statistical analysis.

Table 4-5. Difference for DCT-CT for Two Groups

DCT-CT	KB-conditions group	SB-conditions group
Mean	-6.129	-14.194
SD	10.679	15.403
P(value)	0.022	

4.5.2 CT Scores

By comparing the CT average scores of the two conditions groups in all the sessions, we found that, for every session, the average score of the KB-conditions group was slightly better than the SB-conditions group; also for the whole experiment we found the same result. Figure 4-9 shows the average score for every session. From Table 3 we could confirm this result as the

KB-group had won in 5 of 6 sessions of the CT, but there was no significant difference: so we could say that the two methods had the same efficiency in comprehending the text just after use.

We used the statistical two factor ANOVA with replications. By using this, we found that there was no real difference between the CT scores of the two conditions groups; Table 4-6 showed (p(value)=0.237 > 0.05) that the average score of the KB-group was slightly better than the average score of the SB-group.

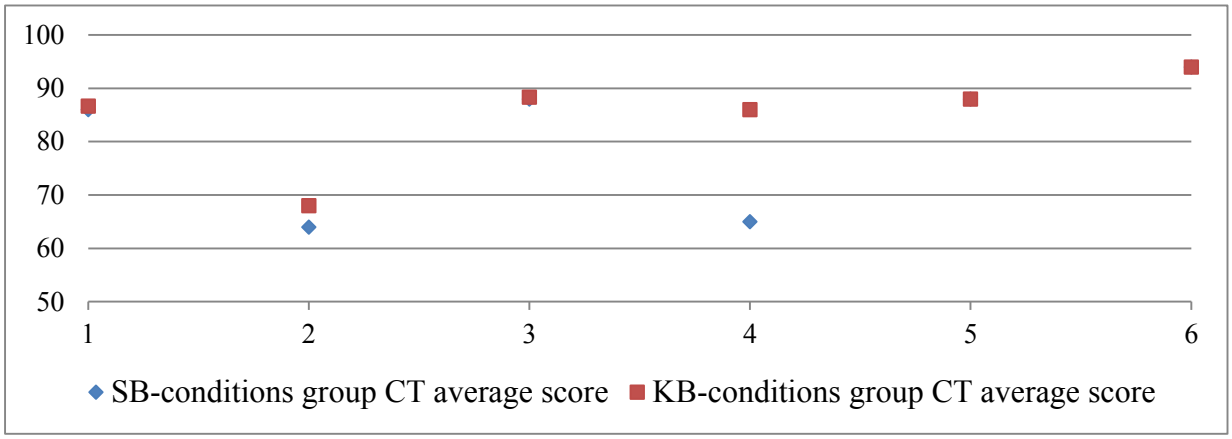


Figure 4-8. CT Average Score of KB-conditions and SB-conditions groups for each session

Table 4-6. CT Scores for Two Conditions Groups

CT scores	KB-conditions group	SB-conditions group
Mean	85.313	80.323
SD	11.986	16.941
p(value)	0.237	

4.5.3 DCT Scores

By comparing the DCT scores of the two conditions groups we found that for every session the average score of the KB-conditions group was better than the SB-conditions group; also, for the whole experiment we found the same result. Figure 4-10 shows the average score for every

session. Again, from Table 3, we could confirm this result, as the KB-group had won in 6 of 6 sessions for the DCT, and the result was significantly different. So we could conclude that the KB-mapping method had better effects in comprehending the text deeply and in recalling the information 2 weeks later. We used the statistical two factor ANOVA with replications. By using this, we found that there was a significant difference between the DCT scores of the two conditions groups; as shown in Table 4-7 (P(value)=0.005 < 0.01) the DCT average score of the KB-group was better than the DCT average score of the SB-group.

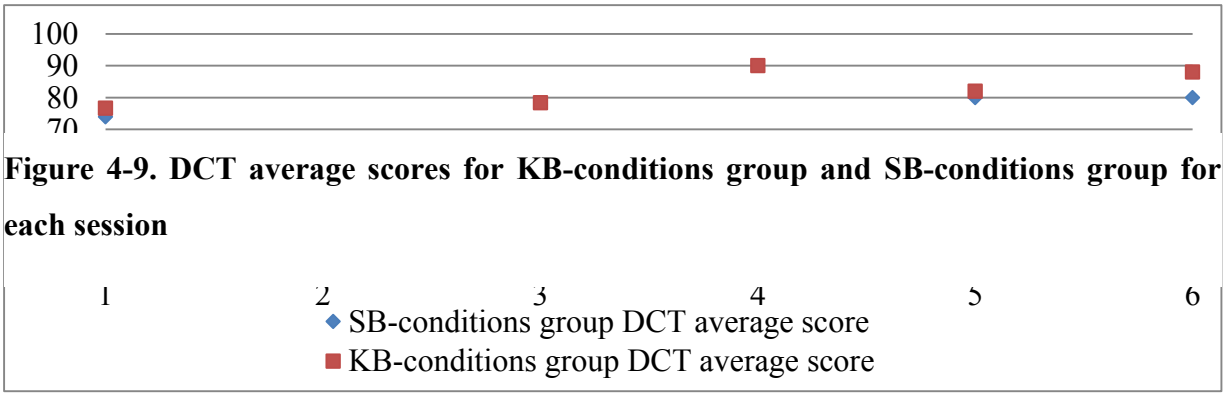


Figure 4-9. DCT average scores for KB-conditions group and SB-conditions group for each session

Table 4-7. DCT Scores for Two Conditions Groups

DCT scores	KB-conditions group	SB-conditions group
Mean	79.063	66.1293
SD	12.083	20.269
p(value)	0.005	

4.5.4 The Questionnaire Results

After we had finished the last session, the participants answered a questionnaire to evaluate KB-mapping and SB-mapping the learning methods by comparison. Table 4-8 shows the results of this questionnaire. Questions (1-6, 9&10) were multiple-choice questions with 5 choices which measured the participants' agreement with the mentioned point of the question. The choices were (A. Strongly agree, B. Agree, C. Neutral, D. Disagree and E. Strongly Disagree). Questions (7&8) were multiple-choice questions with 3 choices which compared the two learning methods. The choices were (A. KB-mapping, B. Both are the same, C. SB-

mapping). To normalize the results of this questionnaire, we tried to summarize all the results and convert them to an arithmetical form: for Questions (1-6, 9&10) (1 Strongly Agree, 0.5 Agree, 0 Neutral, -0.5 Disagree, and -1 Strongly Disagree); and for Questions (7&8) (1 KB-mapping, 0 Both are the same and -1 SB-mapping). As a summarization of the questionnaire evaluation, 0 meant neutral, positive meant agreement and negative meant disagreement, and the absolute value showed the strength of the agreement or the disagreement.

In questions (1, 4&7)(2&5)(3&6), participants agreed that the KB-mapping method was useful to understand English text as was the SB-mapping. They also said that it was useful to answer the CT just after the learning activity. But they agreed that the KB-mapping method was more useful to answer the DCT two weeks later. Also in questions (8, 9), they agreed that the KB-mapping method was easier to carry out, and they liked to use the KB-mapping method in RC task but they needed more time to do it.

In general, we could say that the learners believed that using the KB-mapping was similar to using the SB-mapping for the CT, but the former was more useful for recalling the information after a while and easier to carry out. They liked to use the KB-mapping in the RC task.

Table 4-8. Evaluation of the Proposed Methods for EFL comprehension.

N	Explanation	Av. Ag.
1	Do you think that SB-mapping was useful to understand English text?	0.4
2	Do you think that SB-mapping was useful to answer the test after reading?	0.5
3	Do you think that SB-mapping was useful to answer the test two weeks later?	-0.05
4	Do you think that KB-mapping was useful to understand English text?	0.6
5	Do you think that KB-mapping was useful to answer the test after reading?	0.55
6	Do you think that KB-mapping was useful to answer the test two weeks later?	0.1
7	Which method was more useful to understand English text?	0.6
8	Which method was more difficult to carry out?	-0.6
9	Do you like to use KB-mapping to understand English text?	0.2
10	Do you like to use SB-mapping to understand English text?	0.05

4.6 Considerations

This experiment showed that using the KB-mapping method had almost the same efficiency as using the SB-mapping method for comprehending English text just after the method use (the CT), so we could say that the two conditions groups could understand the text. And by providing a kit to the learners of the KB-group, they were supported to understand the text the same as for the SB-group.

But the KB-mapping method had better efficiency for recalling after some time had passed (the DCT). We could explain these results as because the methodology of building the learner's KB-map requires a learner to concentrate in reading the text, to distinguish two concepts that can be related, and to find the corresponding relation which can connect them together. That is because the kit (all the important concepts and relations) provided by the system forces the learner to first find all the related concepts and relations that connect them directly (in the same sentence), after that it challenges the learner to find all the non-direct relations (already provided by the system) to connect the concepts (in more than one sentence). Also this process requires the learners to understand the information in the text deeply and requires them to comprehend the text as a whole to be able to complete the whole KB-map by using all the kit. So this method helps the learner to comprehend the text deeply.

To confirm the effects of using the KB-map, by checking the effects of the other parts of the text that were not included in the goal map, we did a more detailed analysis about the "not included questions in goal map" of our experiment. For the CT, we found that the KB-group could answer 87% of the not included questions, and the SB-group could answer 80.7%. By applying the student's t-test analyse to compare the two group scores in the CT, we found that there were no significant differences between them.

For the DCT, we found that the KB-group could answer 59.7% of the not included questions, and the SB-group could answer 50.6%. By applying the student's t-test analyse to compare the both group scores in the DCT, we found that there were no significant differences between them. Table 8 shows the results for questions that were not included for the CT and DCT of

the two conditions groups. This analysis showed that the both methods has the same efficiency for the parts of text that are not included in the goal map.

Table 4-9. The not Included Question Scores

	KB-group	SB-group	t-test
CT	87.013	80.737	0.317
DCT	59.740	50.649	0.380

By applying the model of human memory [64] proposed in 1968 by Atkinson and Shiffrin [55], we could say that the required memory, for the process of constructing the learner KB-map, was the long-term memory of the Atkinson-Shiffrin Model. Moreover this process requires very high access to the memory.

On the other hand, for the SB-mapping, the learners can parse the text sentence by sentence to distinguish the important concepts in the sentences and the corresponding relation that can connect them at the same time, but there are no directions that inform the learners to continue building of the SB-map, or to challenge them to go deeply into the comprehension of the text. In the same manner, we can say that the required memory for the process of constructing the learner SB-map is the long-term memory too, the same as in the Atkinson-Shiffrin Model. But the required access to the memory is less than the KB-map situation.

So, we can explain our results by the required access to the learners; long-term memory in order to complete the student map. For the SB-group, the required access is normal, so it helped them to comprehend the text deeply, but not to memorize it long-term. But for the KB-group, the required access is high, so it helped them to comprehend most of the information that they read deeply [56]. Moreover it helped them to memorize the comprehended information long-term.

In short, using the KB-mapping method requires the learners' process meaning more deeply than they normally do with SB-mapping method.

5 ANALYSING OF COGNITIVE PROCESS OF KB-MAPPING AND SB-MAPPING METHODS TO SUPPORT EFL R.C.

5.1 What is the Cognitive Process?

In language learning contexts, reading comprehension is an important learning activity that requires a certain ability from learners to reap its benefits. Reading comprehension poses many challenges to learners who may be slow readers, have insufficient vocabulary comprehension and poor recall of contents [65] [66]. Researchers have supported this learning activity by proposing various methods and strategies with the main goal being to boost comprehension skills in the target subject area. When these methods or strategies are deployed in a language course, the main objective is to improve student reading comprehension of the text in addition to contributing to the acquisition of the Target Language [39] [46] [57].

In our previous research [67], we found that the KB-mapping method [50] [68] has the same efficiency of SB-mapping method for the comprehended information in the Comprehension Test (CT) just after the use of the method. On the other hand, KB-mapping has a better efficiency for recalling the comprehended information in the Delayed Comprehension Test (DCT) two weeks later. The research question "Why KB-mapping is better than SB-mapping in recalling information two weeks later?" is the main question of this research. To answer this question, we need to do more analysing for the cognitive process of the reading task by using KB-mapping and SB-mapping methods.

In general, Cognition is the set of all mental abilities and processes related to knowledge, attention, memory and working memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language [69], The processes are analysed from different perspectives within different contexts, notably in the fields of linguistics, anaesthesia, neuroscience, psychiatry, psychology, education, philosophy, anthropology, biology, systemic, logic, and computer science [70]. These and other different approaches to the analysis of cognition are synthesised in the developing field of cognitive science, a progressively autonomous academic discipline. Within psychology and philosophy, the concept of cognition is closely related to abstract concepts such as mind and intelligence. It encompasses the mental functions, mental processes (thoughts), and states of intelligent entities (humans, collaborative groups, human organizations, highly autonomous machines, and artificial intelligences). [71]. In doing so, we have added a new function to KB-system in order to monitor the progress of map building for the KB-map building and the SB-map building. Then, we analysed this data to investigate the cause of this phenomenon.

5.2 The Relation between Map Building and Comprehension Style

Both SB-map and KB-map are useful tools to promote learners to describe their knowledge or understanding by themselves [45] [62] [45]. From the viewpoint of teaching, the Maps built by learners are promising products to examine the students' understanding [48] [45]. These research studies indicated that the maps resulting from the building process are a useful tool to evaluate learners' understanding. In addition to that, the progress of map-building can be used to evaluate learners' evolving learning behaviours [72].

In general, the style of map-building has effects on learners' comprehension through reading tasks. The relation between map-building style and reading comprehension is not clear, but we think that the building progress of a map is also a good indicator to show learners' ways of comprehension through reading tasks. Accordingly, we propose the monitoring of progress of map-building as a new meth-od to describe the kind of learner's comprehension through reading with a concept map In the next section, we present our proposed method to monitor

the map-building progress during the building process, with an example applied in our experiment.

5.2.1 The Monitoring Method

Generally, a map consists of many propositions, which in turn consists of two nodes and a link. During the map-building process, the learner builds the map by adding new propositions to the map. Map-building is not reading and understanding itself. But it helps in reading comprehension. Then, if the map-building is sentence-by-sentence building, it is not so effective because it is not a structured way, because the nodes are locally connected, and the learner is not getting the full structured comprehension of the text. Building that is sentence-by-sentence building is better. If we can check the way of map-building, we can confirm the effectiveness of the map-building task for reading comprehension.

We suggest comparing the map-building sequence with the text following sequence. In doing so, for the KB-group learners, we give values for all the propositions of the goal map, according to their appearance in the text. After that, we use these values to record the building progress as the order of adding propositions to the learner's map. Also for the SB-group learners, we give values for all the propositions of every learner's map, and we record the building progress as the order of adding to the learner's map.

5.2.2 Example of Map Building Progress Monitoring

To be able to monitor the progress of map-building, the system was modified to automatically upload the learner's map to a server every minute. At the end of each session, we have a sequence of map versions (depending on the session's length) for each learner. By using this sequence of map versions, we record the learner's building sequence as we explained in the previous section. By com-paring the record of the learner's building sequence with the text following sequence, we can tell whether the learner follows the sentence-by-sentence style, i.e., his map-building style is sentence-by-sentence.

As an example, Figure 3 shows part of a simple text we used which talks about computer data storage. Then, computer data storage called storage is assigned value 1.

Computer data storage

Computer data storage, often called storage or memory, is a technology consisting of computer components and recording media used to retain digital data. It is a core function and fundamental component of computers.

In contemporary usage of the words “memory” and ”storage”, “memory” is usually semiconductor storage read-write random-access memory, typically DRAM (Dynamic-RAM) or other forms of fast but temporary storage.

Figure 5-1. Sample of the text used in this experiment (from https://en.wikipedia.org/wiki/Computer_data_storage)

As all learners who follow the KB-mapping method build their maps using the same kit (generated from the goal map), their maps have the same propositions. Thus, we can use the goal map for assigning values for all the propositions of all learners’ maps. Figure 4 shows the order of the propositions according to their appearance in the sample text shown in Figure 3. On the other hand, learners of SB-mapping will have different propositions in their map as every learner is free to select the important nodes and links, but these words are almost the same as the words of the provided kit because the learners are not allowed to use their own words, they are only allowed to extract words from the text. Hence, we have to use the final learner’s map for assigning values for all the propositions of every learner’s map.

As we explain in the previous section, according to the text of Figure 5-1, the proposition (computer data storage is called storage) is the first proposition as shown in Figure 5-3, the proposition (computer data storage is called memory) is the second one, as shown in Figure 5-4, and so on. Figure 5-5 shows the final building sequence of the shown map in Figures 5-3, 5-4.

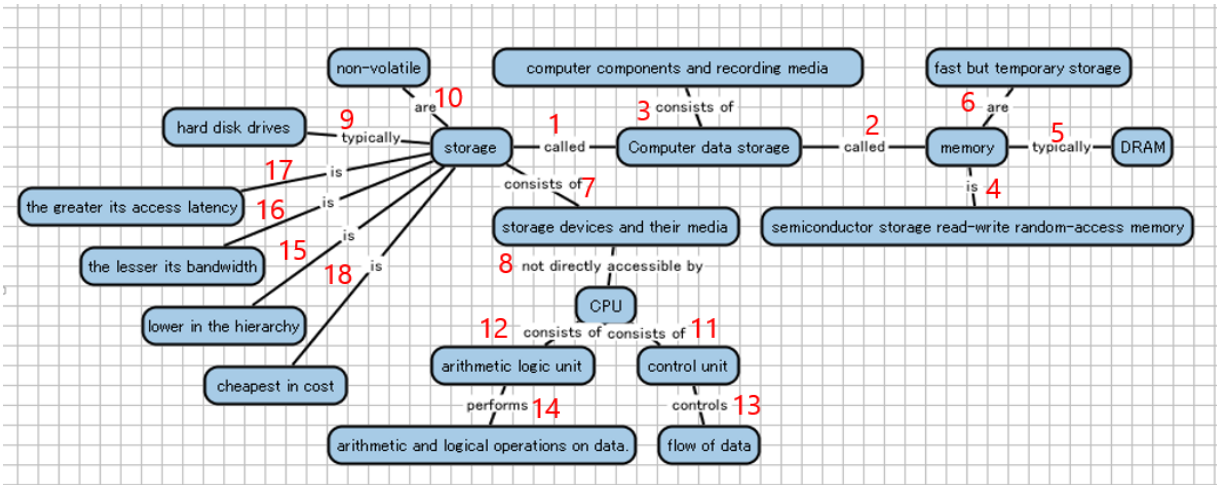


Figure 5-2. Sample of goal map of in this experiment with the values (order) of the Propositions

By doing so, we get the order of the propositions in the situation of following the text sentence sequence, which means that if a learner has the same building sequence, he will be building the map sentence-by-sentence. For every learner, we record the building sequence of the learner's map by recording the sequence of propositions value during the process of building.

After we get the building records for all the learners, we calculate the average anagram distance (AAD) from the text following sequence. The AD is calculated by the absolute value (ABS) of the differences between the text following sequence (TF) and the learner's building sequence (LS), so AD = ABS (TF – LS). Here TF is the order of proposition appearance in the text, and LS is the order of adding propositions to the learner's map. Table 1 shows examples of building records of two learners, one follows the KB-conditions (LS1), and the other follows the SB-conditions (LS2). The first row of Table 5-2 is the order of the TF, and the others rows are the building sequences and ADs of the two learners. The last column is the AAD for every learner's building sequence.

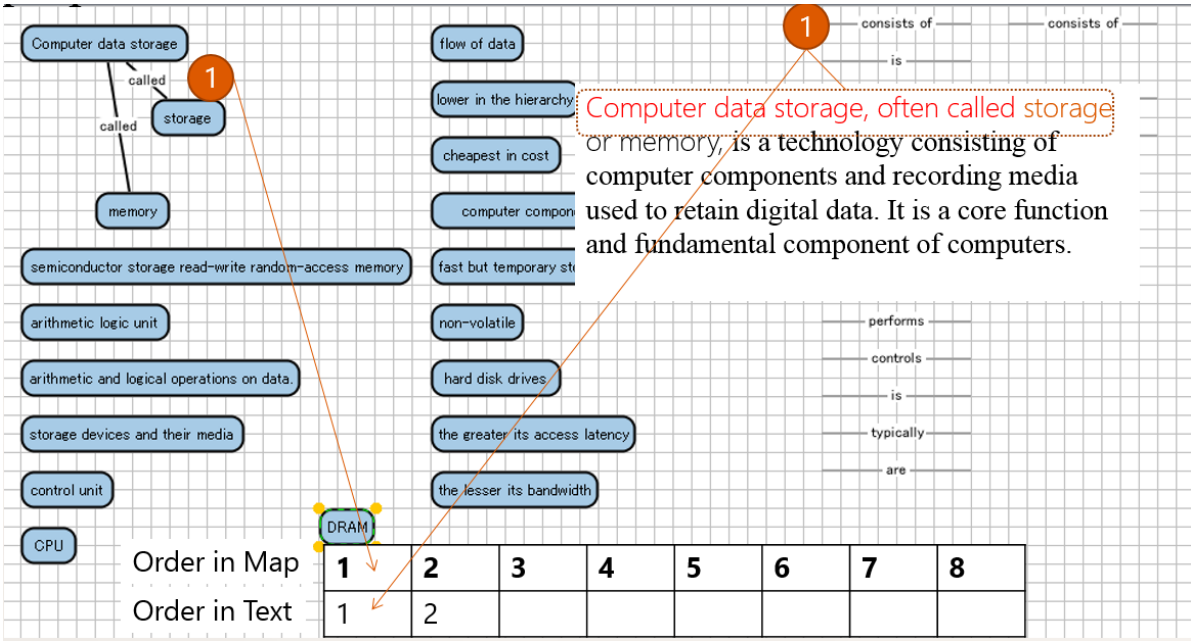


Figure 5-3. Sample of Learner's Map Building Sequence first proposition

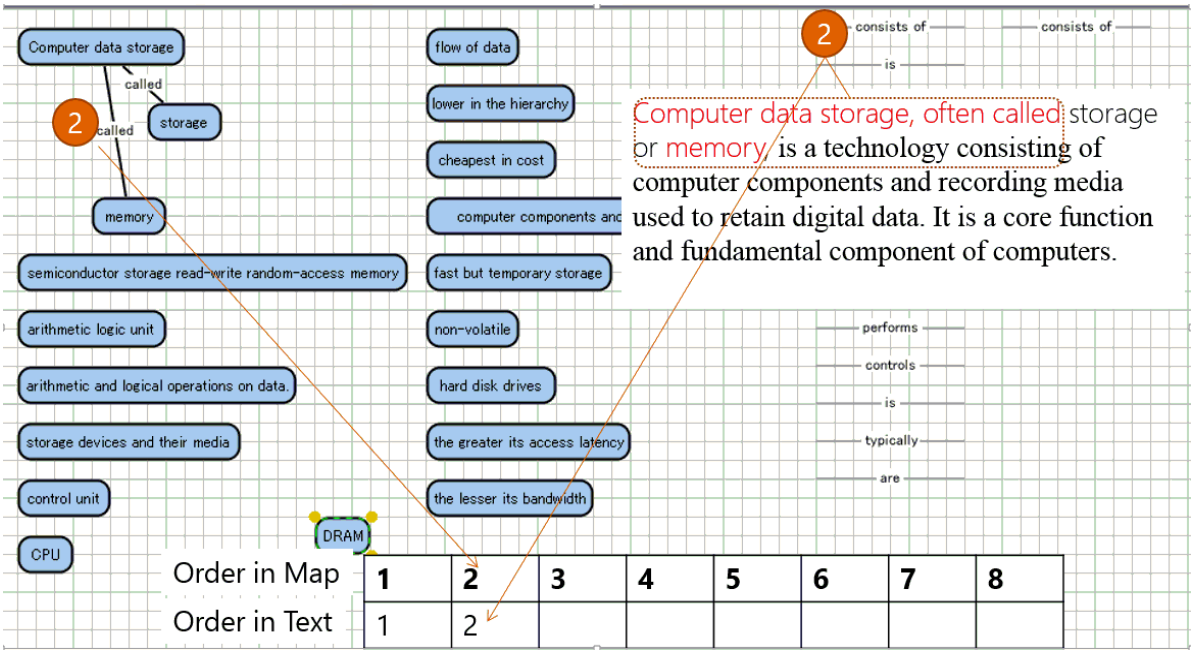
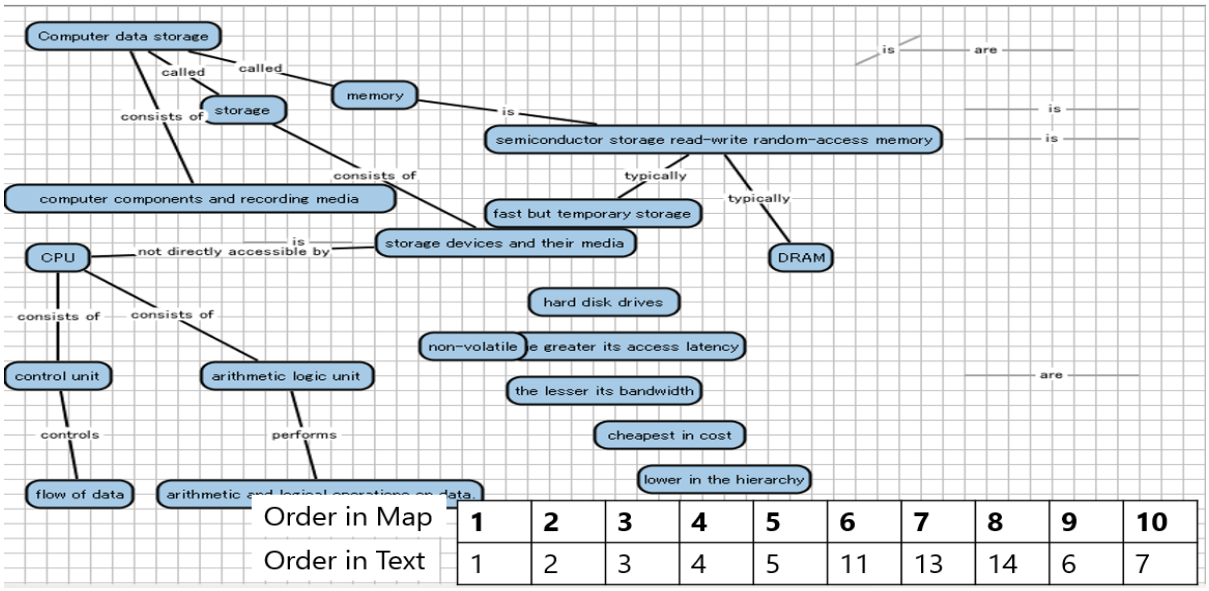


Figure 5-4. Sample of Learner's Map Building Sequence second proposition



Order in Map	1	2	3	4	5	6	7	8	9	10
Order in Text	1	2	3	4	5	11	13	14	6	7

Figure 5-5. Sample of Learner's Map Building Sequence ten propositions

After we got the building records for all the learners, we calculate the average anagram distance (AAD) from the text following sequence. The AD is calculate by the absolute value (ABS) of the differences between the Text following Sequence (TF) and the learner's map building sequence (LS), as shown in Equation 5-1, where AD_i is the Anagram Distance of proposition (i), MA_i the Addition Order of proposition (i) to the learner's map and TA_i the Appearance Order of proposition (i) in Text. Table 5-1 presents an example of anagram distance of the learner building progress that shown in Figure 5-5.

$$\boldsymbol{AD_i = ABS(MA_i - TA_i).} \qquad \textbf{Equation 5-1. Anagram Distance}$$

Table 5-1. Example of Anagram Distance Calculation

TAi	1	2	3	4	5	6	7	8	9	10
MAi	1	2	3	4	5	11	13	14	6	7
ADi	0	0	0	0	0	5	6	6	3	3

The AD is calculated by the absolute value (ABS) of the differences between the text following sequence (TF) and the learner's building sequence (LS), so AD = ABS (TF – LS). Here TF is

the order of proposition appearance in the text, and LS is the order of adding propositions to the learner's map. Table 5-2 shows examples of building records of two learners, one follows the KB-conditions (LS1), and the other follows the SB-conditions (LS2). The first row of Table 1 is the order of the TF, and the others rows are the building sequences and ADs of the two learners. The last column is the AAD for every learner's building sequence.

Table 5-2 Samples of the building records of learner's map in this experiment.

TF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AAD
LS1	1	2	3	4	5	7	15	8	9	11	12	13	16	17	18	6	10	14	
AD1	0	0	0	0	0	1	8	0	0	1	1	1	3	3	3	10	7	4	2.3
LS2	1	2	3	4	5	6	12	7	8	9	10	11	13	15	16	17	14	18	
AD2	0	0	0	0	0	0	5	1	1	1	1	1	0	1	1	1	3	0	0.89

5.3 Experiment Methodology

This research was conducted to explain previous research results [67], to investigate the difference of map-building style through reading task. We planned a new experiment with almost the same conditions of our previous research, with another group of participants.

5.3.1 The Participants

There were eleven participants, all were Japanese third year undergraduate students in the Information Engineering Faculty. Their TOEIC exam scores ranged from 375 to 570, and their TOEIC reading exam scores ranged from 115 to 320, so they had greater differences in reading abilities. We grouped them into two groups, A and B, which had almost the same average scores for the TOEIC exam and the TOEIC reading exam.

5.3.2 Procedure of the Experiment

The experiment was done in six sessions with reading comprehension tasks for six different English texts. In the first session, we introduced the methodology of this learning process, the procedure of every session and the KB-map system. After that the participants started the

learning activity of the session as shown in Table 5-3. For the other five sessions, we started with the DCT of the previous session. We had a complementary time to conduct the DCT of the sixth session along with a questionnaire. During the experiment, each group had Kit Build conditions (KB-conditions) 3 times and Scratch build concept map conditions (SB-conditions) 3 times, too. The conditions were alternated, where the KB-conditions group (KB-group) was considered to be the experimental group and the SB-conditions group (SB-group) was considered to be the control group. We designed the learning activity to be done in a limited period of time to avoid the effects of other supporting strategies. One session consisted of four steps. In the first 10 minutes, both groups were requested to read the whole text by skimming it (dictionary use was allowed). Then, in the next 20 min, the KB-group was required to build the learner's KB-map of the text by using the learner's map builder, and at the same time, the SB-group was required to build the SB-map of the text by using the learner's map builder, too. Within the building time, the learners could read the text to check their comprehension. After that, both groups had 5 minutes to do the CT to measure their comprehension of the text. Except for the first session, learners had a final 5-minute period in which they took the same CT as they had taken 2 weeks before as a DCT to measure their recallable information.

Table 5-3. Procedure of One Session

Time	**KB-conditions**	**SB-conditions**
10 min	Reading the text (using a dictionary was allowed)	
20 min	Making the KB-map by using KB-	Making the SB-map by using KB-
5 min	Comprehension Test (CT)	
5 min	Delayed Comprehension Test (DCT) (2 weeks later)	

The building time (20 minutes) was just about enough for all subjects to complete the maps by both methods. The average number of propositions in the goal maps was 20, and most of the participants could build a map with about 18 propositions in 20 minutes. This limitation of building time is necessary to prevent the use of any.

5.3.3 Experimental Materials

We used six intermediate level texts in information engineering. The texts had the same word count and so the same size, and were taken from Wikipedia; we checked them for grammatical and semantical errors and for continuity since we selectively chose sentences. After that, we created the corresponding concept map (goal map) for every text, by using the Goal Map Editor. The goal map covered the main concepts and relations; also all of the goal maps had almost the same size and structure. We prepared the CTs, which were multiple choice tests with 10 questions of the same level of complexity. Around 80% of the comprehension questions could be answered by the goal map and the others could not. Again we checked all of the materials to be sure they do not contain any errors.

The participants were majoring in information engineering, and they had background information within the texts' domains. Also they are familiar with each domain's English terms. To build a good concept map, it is important for learners to be familiar with the text domain (13). To motivate them to comprehend the texts in a hermeneutic way, we selected general information engineering topics.

To confirm the effects of the subject matter of the text in the reading activity, we conducted a small experiment with eight other third-year students in the Information Engineering Faculty; the average of their TOEIC scores was 447 (the average for the eleven participants was 479). We used the materials for the first session of our experiment, and we requested these students build the KB-map from the kit, without the reading text, within 20 minutes, after that they could read the text for 10 minutes, and finally they had 10 minutes to improve their map. The learners could sup-pose only 6.5% of the relations among nodes (average map score was 0.065/1) without reading the text, and they could improve their maps after text reading to 78.8% (average map score was 0.788/1). The results indicated that the learners' supposing of the relations among nodes has no important effects in the reading activity.

5.4 Results

We did our experiment with eleven students in six sessions. In three sessions we had six participants as the KB-group (Group A) and five as the SB-group (Group B). In the other three sessions, the participants were shifted to the alternate conditions groups, where we had five participants as the KB-group and six as the SB-group. For every session, we compared the CT average scores, the DCT average scores and the differences (DCT-CT) for the two conditions groups.

We got a new kind of data from this experiment, the records of map-building of all learners as SB-conditions and KB-conditions. We analyzed these data in two ways to check what differences there were between the two methods.

5.4.1 Retaining Comprehension

By comparing the average scores of the CT and the DCT for the two groups in every session, we found that the KB-group retained more information in comparison with the SB-group. This experiment showed that for every session, the average difference between the DCT score and CT score of the KB-group was smaller than the average difference of the SB-group.

For every session, we had different texts, goal maps and tests, but for all the sessions, we had the same conditions. So, we proposed to use the differences (DCT -CT) to evaluate the recalled information for the both methods. We gathered these differences for all the six sessions together to have a sufficient number of results for a valid statistical analysis. To confirm this approach is valid, we applied some non-parametric statistical analytical methods to check if we could use all of them together in one analysis. For the differences between the DCT and the CT scores (DCT-CT) in KB-group, we found by Bonferrion's method that there was no difference between any pair of means of all session differences; and for ALPHA= 0.05, the ANOVA Test gave P(value) =0.546. Also, with ALPHA= 0.05, the Friedman test gave P(value) = 0.373, and the Kruskal-Wallis test gave P(value) =0.57. We found that all the differences had similar distributions for p (chi-square distribution). Also for the SB-group differences (DCT-CT), by using the same statistical analysis methods, we found, that there was no difference between

any pair of means of all session differences and all the differences had similar distributions for p (chi-square distribution).

Table 5-4. The Average Difference (DCT- CT) for the Two Groups

DCT-CT	KB-group differences	SB-group differences
Mean	-4.55	-14.42
SD	10.23	9.43
P(value)	0.0005	

We analysed all the differences together by using the statistical two factors ANOVA with replications. In a simple comparison of the score means, for the KB-group, the average difference between the DCT and the CT was -4.55. On the other hand, for the SB-group, the average difference between the DCT and the CT was -14.42. The differences of the KB-group were lower than the differences of the SB-group for all the sessions. The value of the ANOVA Test P(value) =0.0005< 0.05 indicated that there were differences in the recalled information of the two groups. So we could say that the KB-mapping method helped the learners to retain their understanding for a longer time. Table 5-4 shows the details of the statistical analysis.

5.4.2 The Map Size

First, we checked if the learners' maps corresponded with the goal map that was created by the supervisor. For learners of the KB-mapping method, we used the map scores to evaluate the degree of correspondence, and we found that the average map score of all sessions was 71.2%. This indicated that the learners' maps by the KB-mapping method corresponded with the goal maps. For the SB-mapping method, the learners' maps had different nodes and links in comparison with the goal map. So comparison was not possible in a direct way, and we tried to calculate the average common parts with the goal map. We found that the learners' maps included 69.8% of the goal maps. This indicated that the learners' maps of SB-mapping method corresponded with the goal map too.

The records of map-building of the two methods contained the building progress during the building time. We added new functions to our system to summarize the records of the building

by the size of map, number of linked nodes and number of linked links. In every session, the building time was 20 minutes, during this time all the learners were building the learner' map, every minute the learners were integrating new nodes and links to the learner's map. So our method of analysis was to count the number of linked links and nodes in the learner's map in every minute. For all sessions, we calculated the average number of nodes and links for all the learners of the KB-mapping method and compared them with the average of the SB-mapping method. We found, as shown in Figure 5-6, that both methods had almost the same map size progress during the building time, and the average final map size was almost the same for both as well. So we could confirm that the map size had no effects in the reading comprehension process.

In previous presentations of our research, some listeners stated that the provided kit was likely giving underlined information to learners. In other words, the map-building of the KB-mapping method was easier to do, and the required time for building was less than the SB-mapping case. Listeners had this opinion because the kit contains the important words in the text, but we have to distinguish be-tween the important words and the important information. The KB-mapping method supports the learners by these important words to reduce the load of selecting the words from text, by using these words, the learners can find the important information in the text to use in structuring the map.

From this result, we could confirm that the kit provided to KB-conditions learners had not given underlined in-formation to learners in comparison with the SB-mapping learners who were not provided. Because both groups of learners could build maps of almost the same size, and the progress of the map size, during the map-building, was al-most the same for both, we could confirm that the provided kit was not too much support because the map size, which is often used as measure of activity of map-building, was not different.

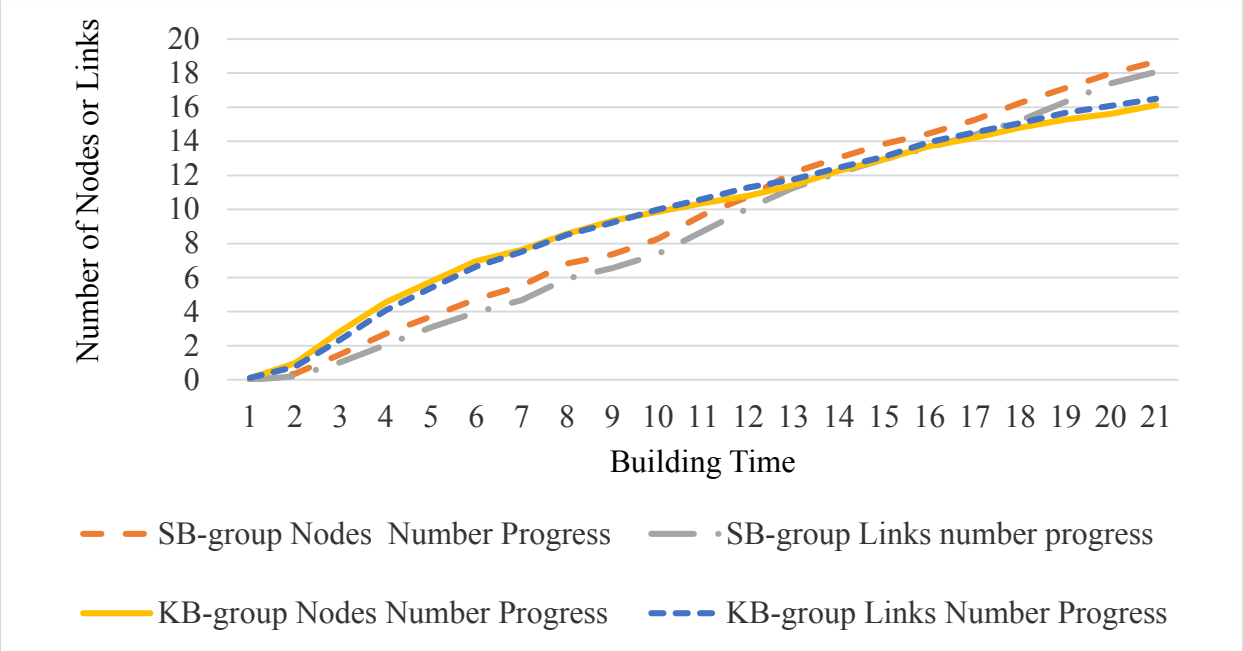


Figure 5-6. Map Size Progress during the Building Time

5.4.3 Following Text Sequence

The building records of the two methods contain the building sequence during the building time, so we analyzed the sequence of map-building during the building time. For every session, for the KB-mapping method, we gave an or-der for all the propositions of the goal map, according to their appearance in the text, and we recorded the building sequence as the order of adding propositions to the learner's map. For the SB-mapping method, we gave an order for all the proposition of the final learner's map, according to their appearance in the text, and recorded the building sequence as the order of adding propositions to the learner's map.

We calculated the absolute AD of every building sequence from the text following sequence and we found that the KB-group average AD of every session was higher than the SB-group values, as shown in Figure 5-7.

Also, we calculated the average Pearson product-moment correlation coefficient between the text following sequence and the building sequence of every learner in every session. We found that the SB-group building sequence had a stronger correlation than the KB-group building

sequence, so during the map-building process, the SB-group followed the sequence of appearance in the text.

To check the effects of following text sequence, we calculated the average Pearson product-moment correlation coefficient between the learners' average AD and their CT and the DCT scores for the two groups. We found as shown in Table 5-5, that there was a positive correlation between the scores of the SB-group and the building sequence, but there was no correlation for the KB-group.

From these results, we could confirm that, during the map-building, the learners using the SB-mapping method had followed the sequence of sentences in the text, but the KB-mapping learners had not.

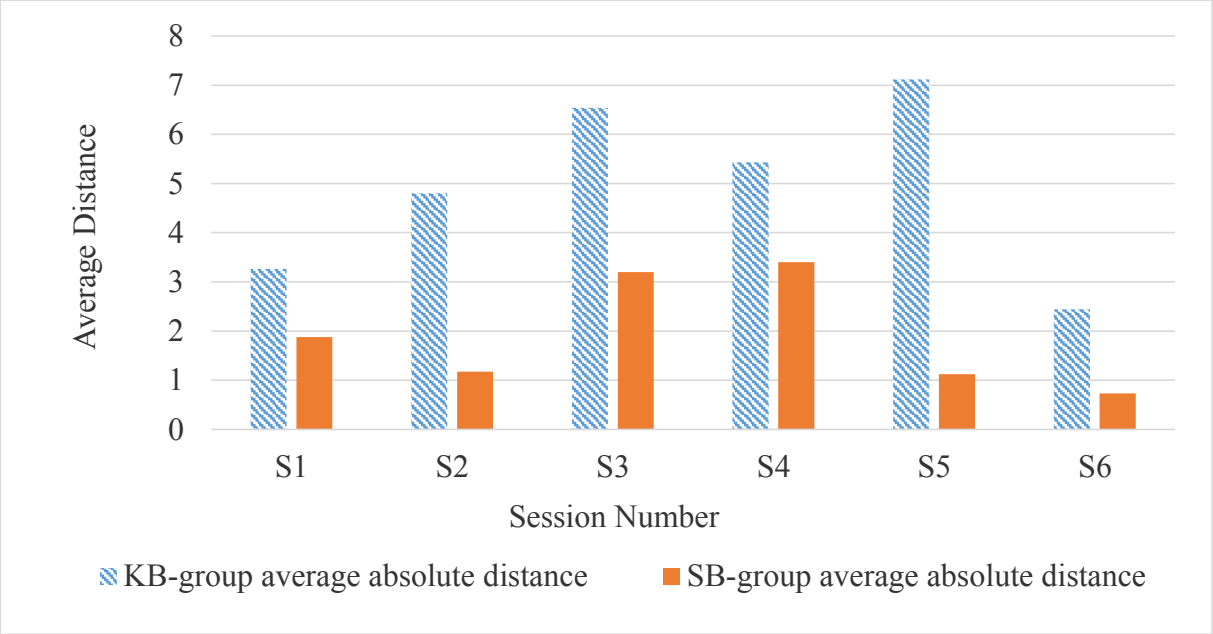


Figure 5-7. The Average Absolute Distances for the two Groups in all Sessions

Table 5-5. The Average correlations between the learners' average Anagram Distance and Scores

Session	S. 1	S. 2	S. 3	S. 4	S. 5	S. 6

SB-CT	0.92	0.93	0.83	0.56	0.81	0.99
SB-DCT	0.47	0.77	0.80	0.50	0.58	0.85
KB-CT	0.22	0.17	0.13	-0.31	-0.06	0.10
KB-DCT	-0.16	0.27	-0.13	-0.33	0.23	-0.24

5.4.4 The Effects of Learner's Reading Ability

As noted earlier, the participants' TOEIC exam scores ranged from 245 to 570, and their TOEIC reading exam scores ranged from 115 to 320, so they had greater differences in reading abilities. From the viewpoint of reading comprehension, the learners' reading ability has a big influence in text comprehension. To check the effects of reading ability during the learning process by using KB-mapping and SB-mapping methods, we checked the correlations between learner's TOEIC reading scores and the learner's average AD. As shown in Table 5-6, we found that, for the SB-mapping method average AD, there was a correlation of 0.56 with TOEIC reading score, this correlation was statistically slightly significant at the 10% level. In contrast, for the KB-mapping method average AD, there was a weak correlation without statistical significance.

Also to check the effects of English language ability during the learning process by using KB-mapping and SB-mapping methods, we checked the correlations between learners' TOEIC exam scores and the learner's average AD of the two methods. As shown in Table 5-7, we found that, for the SB-mapping method AD, there was strong correlation of 0.73 with the TOEIC exam score. The correlation was statistically significant at the 5% level. In contrast, for the KB-mapping method AD, there was a weak correlation without statistical significance. From these results, we could confirm that the KB-mapping method helped the learners to avoid the sentence-by-sentence map-building style, regard-less of their reading ability.

Table 5-6. The Relation between Learner AD and Reading Ability

Learner	Reading Scores	KB-A-D	SB-A-D
L 1	75	4.50	1.30

L 2	175	4.34	0.58
L 3	195	5.29	1.76
L 4	225	3.29	2.92
L 5	230	2.35	2.00
L 6	235	5.78	1.17
L 7	240	5.53	2.01
L 8	285	5.63	2.62
L 9	305	5.83	2.22
L 10	315	6.00	1.67
L 11	320	4.00	2.92
	CORREL	0.27	0.56
	P(value)	0.421	0.073

able 5-7. The relation between learner's Anagram distance and his reading ability

Learners	TOEIC Scores	KB-A-D	SB-A-D
L 1	375	4.34	0.58
L 2	445	5.78	1.17
L 3	450	2.35	2.00
L 4	455	5.29	1.76
L 5	480	4.50	1.30
L 6	480	3.29	2.92
L 7	480	5.53	2.01
L 8	505	5.63	2.62
L 9	525	6.00	1.67
L 10	530	5.83	2.22
L 11	570	4.00	2.92

	CORREL	0.21	0.73
	P(value)	0.534	0.011

5.5 Considerations

From the results of this experiment, first we confirmed again the results of our previous research 14) , that using the KB-mapping method has almost the same efficiency as using the SB-mapping method for comprehending English text just after using the mapping methods (based on CT results), so learners for the two methods could understand the text. But, the KB-mapping method has a better efficiency for recalling the comprehended information after some time (demonstrated by DCT results). Second, we could confirm that the kit provided for the KB-mapping learners does not give any underlined information or extra support for the building process in comparison with the learners of SB-mapping method, who had to build all the map nodes and links by themselves. This was based on out finding that learners for both methods had the same map size progress during the building process.

The third and most important result of this research, was the relation between the building sequence and the text following sequence: we could confirm that the learners of the SB-mapping method were following the sequence of the text through the map-building. In other words, they were parsing the text sentence-by-sentence to generate the concepts and the relations from the text. As we mentioned be-fore, this style of reading is not effective for comprehending the text. That is because this style of reading does not help learners to comprehend the text in a structural form, which means that the learners could comprehend the text as sepa-rated sentences or paragraphs. That will not help learners to keep their comprehension for a long time. Subsequently, they could answer the CT, but not the delayed test DCT. On the other hand, the learners of the KB-mapping method were not following the sequence of the text through the map-building. In other words, they were not parsing the text as the SB-mapping learners did, but they could answer the CT as well as the SB-mapping learners did, and significantly, they could answer the DCT better than the SB-mapping learners did. So, for our particular experimental setting, we can confirm that the KB-mapping method

helps learners to deeply comprehend the text in a more structural form, and this comprehension helps the learners in recalling the comprehended information later.

Also from this experiment, we could confirm that the reading ability of learners had effects on the map-building style in the learning with the SB-mapping method. But in the learning with KB-mapping method, the learners could avoid the sentence-by-sentence map-building style regard-less of their reading abilities.

6 DISCUSSIONS, CONCLUSION AND FUTURE WORK.

In this dissertation, we describe the effects of using KB-mapping method as a supportive tool for the RC of English texts as EFL reading. Throughout the three experiments, we could confirm the usability of KB-mapping method in Supporting EFL RC.

We have conducted three experiments composed of six experimental RC sessions. Overall, from the first experiment, we could say that the use of KB-mapping as learning supportive tool for EFL RC is good as SU strategy in the short term, but it is so better for the long term. From the second experiment, we could conclude that using KB-mapping as a learning support tool for EFL RC was as good as using SB-mapping from the short-term viewpoint, but the former was better from the long-term viewpoint, and from the third experiments, we could confirm the results of the second experiment. Due the results of the third experiment, this effectiveness can be explained by the building process of the two methods, where the building sequence of the two methods indicated that the SB-mapping method learners had followed the sentences sequence of the text, but the KB-mapping method learners did not. As we mentioned, the SB-group learners had comprehended the text as individual parts, so their comprehension was good in the CT, but they could not recall in the DCT. In the other side, the KB-group learners had comprehended the text as a whole in a more structural form, so their comprehension was good in the CT and they could recall more in the DCT.

6.1 Limitation of Experiments

The conducted experiments need a special environment to keep the fair of experimental conditions. To investigate the effects of methods in the short and long term points of view, we needed special analyzing methods for the performances in the learning processes. So we

planned these three experiments as a set of six sessions, every session had a limited number of participants. The monitoring and analyzing requirements were very high, so the number of participants was low (4~6).

Even given its limitations, this study provides many ideas for ways to modify teaching practices. It seems that KB-mapping can help to stimulate and challenge students to look deeper into their reading. The scope of this study was only limited to the RC. We suggest that in future research the scope should be expanded in terms of the other three important skills: writing, speaking and listening. By widening the scope, researchers can get a clear view of the utilization of KB-mapping in all aspects.

6.2 Psychology Point of View

Cognitive psychology has shown that the way knowledge is structured in the memory that determines the ability to retain, recall and use it to solve problems [54], for our KB-mapping method, the learner try to build the KB-map, which is a structured form of the knowledge, by using the provided information from the original text, so we found that the KB-mapping method users could retain the knowledge as other methods' users but they were more effective in the recalling.

In generally, the using of KB-mapping method need a concentration in reading the text and need to read with attention to distinguish the two concepts, that can be related and to find the corresponding relation, that can connect them together, in the same time, this process required the learner to understand the information in the text deeply and required him to comprehend the text in whole. So we can explain our result by the required high load on the learner memory to comprehend deeply the whole text to complete the learner's map, this load force the learner's memory to keep most of the information, that he has already comprehend.

From the viewpoint of hermeneutic circle, that KB-mapping method help the learners to understand the text in a spiral hermetical form, by building the concept map from the text, they could understand the parts (Nodes, Links) from the whole map and the whole text (KB-map) from the nodes and links. Also, this method encourage the learners to comprehend the text in

more deeply form by requiring him to finish all the kit to build the map. We suppose that these requirements urge the learners to apply the hermeneutic circle for more times as the hermeneutic spiral, so the learners can get deeper understanding of the text and he could remember and recall it after a while.

We could conclude that the differences between the recalled information two weeks later, checked in the DCT, and comprehended information, just after the building process checked in the CT, for the both conditions group in this experiment is derived from the difference of the RC through map-building. For SB-mapping method, the comprehension through the SB-map-building is similar to sentence by sentence RC, which is not useful to comprehend the text in full structural form, also for recalling after two week. But for KB-mapping method, it is not similar to sentence by sentence RC, which is helpful for comprehending the text in more structural form, and for recalling two weeks after.

From perspectives of English education, one of goals in reading is to comprehend English text without any help. But recent overviews of EFL reading have argued that discourse comprehension skills contribute to reading abilities [73] [41] [74]. Many researchers have suggested to use some methods or strategies to support this learning task. We propose KB-mapping and SB-mapping methods to serve as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks provided by the kit. Throughout this research, we can confirm that the learners with low reading ability mostly tied to follow the sentence by sentence map-building style, and they need to be supportive tool to avoid the limitations of this comprehension.

6.3 Future Work

Our next goal is to investigate the effects on improving a subject's comprehension skills and acquisition of the English language, by generalizing the results with larger groups. This research will be due over a longer time period and the study will involve more participants at different levels. Also to investigate the effects of learning methods for the learners who have different levels of reading abilities, and how to improve our method to support all kinds of

reading and all levels of learners. Also, we are going to design adaptive support environment for RC based on the considerations of this research and implementation of the monitoring function.

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