Experimental Evaluation of the KB-mapping Method to Avoid Sentence-by-Sentence Map-building Style in EFL Reading with Concept Mapping

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Abstract Previous research studies on supporting EFL (English as a Foreign Language) reading showed that the Kit Build concept mapping (KB-mapping) method provided better efficiency than the Scratch Build concept mapping (SB-mapping) method when evaluated by a delayed comprehension test two weeks after the reading activity, although there was no difference in test results immediately following the reading activity. In the present study, we set out to investigate the following research question “Why does the KB-mapping method have better efficiency than the SB-mapping method in recalling the comprehended information two weeks later although there is no difference just after the reading?” We had observed that there was a difference in map-building behaviors between KB-mapping and SB-mapping methods, so we made the assumption that “KB-mapping method does not promote building the map sentence-by-sentence, although the SB-mapping method does”. To confirm this assumption, we used an experiment to compare the learners’ map-building progress by the KB-mapping and SB-mapping methods. In the experiment, we monitored the performance of learners in terms of the size of the maps and the progress they made for building maps. We added new functions to our system to record the building process of every learner. We observed that SB-mapping learners tended to use the sentence-by-sentence map-building style, but KB-mapping learners did not. Although there have been no previous research studies about map-building style in supporting reading comprehension with concept mapping, many researchers have indicated that sentence-by-sentence reading is not a good way to comprehend content deeply and keep it in memory for a long time, although sentence-by-sentence reading is useful to understand content rapidly and to keep it for a short time. In map-building, we suspected the same disadvantages and advantages would be true, and this would explain the results, KB-mapping method helps learners to avoid the sentence-by-sentence map-building style, but the SB-mapping method cannot help learners escape from this style of map-building. Based on these results, we will design adaptive support for reading comprehension in our future work.

Keywords: reading comprehension, building progress, sentence-by-sentence map-building style

1. Introduction

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(1). 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(2–4).

Reading comprehension in the EFL context is a special case because it is a complex, dynamic, multi-componential and multi-dimensional task in the learning process(5). It is a continuous process of multiple interactions between the readers’ background knowledge in their Mother Language and the knowledge exposed to in the Target Language (here English)(6). Broadly speaking, reading comprehension for EFL is the same as for Mother Language reading comprehension, but it is slower and less successful than Mother Language 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(7).

The Scratch Build concept mapping (SB-mapping) method is one of the newest strategies used to support the reading comprehension learning activity, and it gives good effects on reading comprehension of EFL learn-
SB-mapping is a visual representation of knowledge, which can be employed as a learning strategy by learners to find the relationship between their current knowledge and new information\(^{(9)}\). Many researchers have confirmed that EFL learners who used concept mapping gained high understanding in reading comprehension\(^{(3, 4, 10, 11)}\). Also, many studies have proved that the concept mapping or semantic mapping technique can improve the learners’ reading comprehension because they could understand the text more easily through the concept map\(^{(3, 9, 12, 13)}\).

In our previous research\(^{(14)}\), we found that the KB-mapping method\(^{(15, 16)}\) has the same efficiency as the SB-mapping method for the comprehended information in a comprehension test (CT) just after using 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. In this study, we considered as the main question: “Why is the KB-mapping method better than the SB-mapping method in recalling information two weeks later although there is no difference just after the reading?” To answer this question, we added a new function to the KB-system in order to monitor the progress of map-building for the KB-map and the SB-map. Then, we analyzed the obtained data to investigate the cause of this phenomenon.

### 1.1 EFL Reading Comprehension

“Comprehension” as a concept is defined as “the ability to understand something” in the Oxford English Dictionary (O.E.D.). The definition in the Cambridge Dictionary is “the ability to understand completely and be familiar with a situation, facts, etc.” For the purpose of this research, “reading comprehension” will be 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 learner triggers knowledge outside the text/message.

One of the most common styles of reading in EFL reading comprehension learning activities is the sentence-by-sentence style\(^{(17)}\), in which learners can understand the text as separate sentences only, not as a whole structure\(^{(19)}\). In general, learners using this style of reading can comprehend the sentences of the text, and they can use this comprehension just after the reading task, but they cannot keep their comprehension for a long time because this kind of comprehension is easily forgotten after a while. Many research studies in schema theory have concluded that comprehension of the whole structure of a text is effective for recalling the text after a while\(^{(1, 19–22)}\).

Most low reading ability learners in EFL reading comprehension are tied to sentence-by-sentence reading\(^{(23–26)}\). This style’s comprehension is effective for comprehending the EFL 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. In our previous research, we found that the KB-mapping and SB-mapping methods have the same efficiency for comprehending the EFL text just after the method use, but the KB-mapping method has better efficiency for recalling the comprehended information later. Through the experimental use of previous research, we have observed that there is a difference in map-building behaviors between KB-mapping and SB-mapping methods; we perceived that the SB-condition learners were tied to the sentence-by-sentence map building style, while the KB-condition learners were not. The same tendency for previous results and the characteristics of sentence-by-sentence reading suggest that our perception can be attributed to sentence-by-sentence reading having the same disadvantages and advantages as sentence-by-sentence map-building style. So we decided to compare the KB-mapping and SB-mapping methods for their ability to support learners in EFL reading comprehension tasks to avoid the sentence-by-sentence style of map-building. We conducted an experiment to investigate the effects of map-building by the two methods, by monitoring their building performance during the building process.

Some researchers have proposed the concept of a hermeneutic circle\(^{(27)}\), which describes the process of understanding a text hermeneutically. As explained in Wikipedia, “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 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. It is a circle, as shown in Figure 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 found within its cultural, historical, and literary context". By applying this circle many times readers can get a deeper understanding of the text and they can remember and recall it after a while(28) as it shown in Figure 2.

From the viewpoint of hermeneutic theory, map-building methods promote the hermeneutic spiral model of reading comprehension because the understanding of the parts (nodes and their relation) is derived from the understanding of the whole text (concept map). And the process of integrating a new proposition into the map occurs as the improvement of comprehending the whole map through the understanding of the new parts. This process has to be applied many times in order to complete the whole map. But in practical use of SB-mapping, low reading ability learners build maps sentence-by-sentence. In such cases the map-building does not promote the hermeneutic spiral model, it is only using the understanding of the parts (nodes and links) to improve the comprehension of the whole text (concept map).

1.2 SB-mapping Method

SB-mapping provides learners with opportunities to become actively involved in their learning while linking knowledge to their long-term memory(11). Through the use of concept maps, learners have opportunities to organize their thoughts in a graphic/visual format, while connecting concepts and linking prior knowledge to new knowledge(4). Accordingly, related concepts become connected rather than being fragmented. Concept mapping also provides learners with opportunities to reconsider their own thinking, as they reflect on their conceptual understandings. The process of map-building has a positive impact on learners’ awareness of the reading process and learners can have more control over reading comprehension in English by visually representing what is conveyed in the texts they read.

In general, using the SB-mapping method has many advantages in the reading comprehension process, such as helping learners brainstorm and generate new ideas. Moreover, it encourages learners to discover new concepts and 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.

In general, in order to build a good SB-map, learners are required to start the building with the main concept (main idea), integrating the map by adding the key concepts and extending it by adding the detailed concepts(13). In studies using SB-maps to support reading comprehension during the reading process, learners have the freedom to build them as they think(8, 9, 11). There are no constrains for the building process. The quality of the building process depends on the learners’ ability, for example, some poor learners try to parse the text sentence-by-sentence to extract the concepts and to integrate them in their map without caring about the kind of concept. The final map is almost correct but the building process is not good. This kind of building process is not effective to support reading comprehension.

In practical uses of the SB-mapping method in our previous experiments, we noticed that the low reading
ability learners were parsing the text sentence-by-sentence to extract the concepts and the relation in order to add them to their map. This style of building is similar to the sentence-by-sentence reading style. Also the results of our previous research indicated that the learners using the SB-mapping method had the similar tendency as sentence-by-sentence reading, so in the present study, we investigated the effects of the SB-mapping method during the building process in avoiding the sentence-by-sentence map-building.

1.3 KB-mapping Method

The 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”(29). The KB-map is a special kind of concept map. The creation of a 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, a supervisor does the first step by creating the goal map from a text, after that he can generate a kit from the goal map by dividing the goal map into concepts and relations, and then he provides learners with this kit. The second step is done by the learners who are tasked to build the concept map (called a learner’s map) by recognizing the concepts and the relations that are 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 control and redirection of the learners; it helps evoke prior knowledge through KB-map creation. This method can be used in any discipline to help learners to make connections between ideas, but the provided kit (all the important concepts and relations) always controls the process.

Reading comprehension refers to the ability to understand information presented in a written form. The KB-mapping method, in its applications, helps 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 scan 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 the important words). As the important information contains recognition of the relations among the words to complete the whole structure of the text, it cannot be found completely without thinking about the structure of the text. The KB-mapping method reduces the learners’ load in the selection process and lets the learners focus on the structuring process. It has been proved that using the KB-mapping method to support EFL reading comprehension was useful to help the learners to comprehend the text deeply, and to recall it after a while(14).

We have already developed a system called the “KB-map System”(29), our new version of the Learner’s Map Builder has functions to add concepts and relations to the learners’ map, and it has the mark and click functions. The functions of adding nodes and links give the builder better usability for building SB-map. So the learner’s map builder can be used as a computerized SB-map editor in addition to the original use of creating the KB-map from the provided kit. Moreover, with the Point & Click functionality, learners can select one or more words, and click on a creation mark to create a new node, link or relation and create SB-maps very simply.

2. The Relation between Map-building Style and Comprehension

Both SB-maps and KB-maps are useful tools to promote learners to describe their knowledge or understanding by themselves(30–32). From the viewpoint of teaching, the maps built by learners are promising prod-
ucts to examine the students’ understanding\(^{(10,15)}\). 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 behaviors\(^{(33)}\).

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 method 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.

### 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.

### 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 comparing 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.

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.

By doing so, we get the order of the propositions in

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**Figure 3.** Sample Text Used in the Experiment (from https://en.wikipedia.org/wiki/Computer_data_storage).
EXPERIMENTAL EVALUATION OF THE KB-MAPPING METHOD TO AVOID SENTENCE-BY-SENTENCE MAP-BUILDING STYLE IN EFL READING WITH CONCEPT MAPPING

Table 1. Samples of the Building Records of Learner’s Map in 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  | 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 | 5 | 1 | 1 | 1 | 1  | 1  | 1  | 1  | 3  | 0  | 0.89|

(TF: Text following sequence; LS1, LS2: Learners’ building sequences; AD1, AD2: Anagram Distance of the two learners; AAD: Average AD)

![Figure 4. Sample of Goal Map in the Experiment, with Values (Order) of the Propositions.](image)

the situation of following the text sentence sequence, which means that if a learner has the same building sequence, she 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 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.

In this paper, we compared the ADs for the two styles of map-building, by comparison with the TF. The comprehension is a reflection of the style of map-building. The bigger AD indicates the learner is not following the text sequence in map-building, and the task of map-building is better for supporting reading comprehension. We can explain this assumption as the general structure of the text, which consists of some paragraphs. The central concept (main concept) usually is presented in the first paragraph, and in the other paragraphs, some key and supportive concepts are presented. For the big AD,
the learner is not following the text sequence in adding new concepts to the map, and her way to build the map is preferable. In other words, the learner is building the map by adding the key concepts first and after that by adding the supportive concepts. On the other hand, for the small AD, the learner is following the text sequence in adding new concepts to the map, and her way to build the map is not useful for her understanding.

3. Experiment Methodology

This research was conducted to explain previous research results\(^{(14)}\), to investigate the difference in map-building style through reading tasks. We planned a new experiment with almost the same conditions as our previous research, with another group of participants.

3.1 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.

3.2 Procedure for 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 2. 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 minutes, 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.

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 other supporting method or strategy, like memorizing.

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 suppose 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.

4. Results

We conducted 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.

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 both methods. We collected the differences for all six sessions 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 the KB-group, we found by Bonferroni’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\(\text{value}=0.546\). Also, with ALPHA=0.05, the Friedman test gave P\(\text{value}=0.373\), and the Kruskal–Wallis test gave P\(\text{value}=0.57\). 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).

We analyzed 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 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

<table>
<thead>
<tr>
<th>Table 3. (DCT-CT) for the Two Groups.</th>
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<tbody>
<tr>
<td>DCT-CT</td>
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<tr>
<td>Mean</td>
</tr>
<tr>
<td>SD</td>
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<td>P(\text{value})\</td>
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of the SB-group for all the sessions. The value of the ANOVA Test $P(\text{value})=0.0005<0.05$ 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 3 summarizes the statistical analysis values.

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’s 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, 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 between 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 information 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 almost 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.

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 order 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 6.

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 4, 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.

<table>
<thead>
<tr>
<th>Session</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-CT</td>
<td>0.92</td>
<td>0.93</td>
<td>0.83</td>
<td>0.56</td>
<td>0.81</td>
<td>0.99</td>
</tr>
<tr>
<td>SB-DCT</td>
<td>0.47</td>
<td>0.77</td>
<td>0.80</td>
<td>0.50</td>
<td>0.58</td>
<td>0.85</td>
</tr>
<tr>
<td>KB-CT</td>
<td>0.22</td>
<td>0.17</td>
<td>0.13</td>
<td>−0.31</td>
<td>−0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>KB-DCT</td>
<td>−0.16</td>
<td>0.27</td>
<td>−0.13</td>
<td>−0.33</td>
<td>0.23</td>
<td>−0.24</td>
</tr>
</tbody>
</table>

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, 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 6, 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, regardless of their reading ability.

4.5 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 our 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 before, 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 separated 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 regardless of their reading abilities.

5. Conclusion and Future Work

Overall, from this research, we concluded that
using the KB-mapping method as a learning supportive tool for reading comprehension is as good as using the SB-mapping method in the short term, but the KB-mapping method is better for the long term. We explain this in terms of the building process of the two methods: 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. Our results showed the SB-group learners had comprehended the text as individual parts, so their comprehension was good in the CT but they could not recall the information as well 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 it was good in the DCT, too.

From the viewpoint of the hermeneutic circle, the KB-mapping method helped learners to understand the text in a spiral hermetical form, and 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 encouraged the learners to comprehend the text in a deeper form by requiring them to finish the kit to build the map. We suppose that these requirements urge the learners to apply the hermeneutic circle more times as the hermeneutic spiral, so the learners can get deeper understanding of the text and they can remember and recall it after a while.

We concluded 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 learners of both methods was derived from the difference of the reading comprehension through map-building. For the SB-mapping method, the comprehension through the SB-map-building is similar to sentence-by-sentence reading comprehension, which is not useful to comprehend the text in a full structural form, or for recalling it after two weeks. But the KB-mapping method is not similar to sentence-by-sentence reading comprehension, and so it is helpful for comprehending the text in a more structured form and for recalling it later.

From the perspective of EFL education, one of the goals in reading is to comprehend English texts without any help. But recent reviews of EFL reading have argued that discourse comprehension skills contribute to reading abilities\(^\text{(34-36)}\). Many researchers have suggested use of 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 in organizing knowledge structuring it, even though the structure must be built up piece by piece with small units of interacting concepts and propositional frameworks provided by the kit. Through this research, we confirmed that learners with low reading ability were mostly tied to the sentence-by-sentence map-building style, and they needed a supportive tool to avoid the limitations of this comprehension.

Our next step is to investigate the effects of learning methods for 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 want to design an adaptive support environment for reading comprehension based on the considerations of this research and implementation of the monitoring function.

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References


EXPERIMENTAL EVALUATION OF THE KB-MAPPING METHOD TO AVOID SENTENCE-BY-SENTENCE MAP-BUILDING STYLE IN EFL READING WITH CONCEPT MAPPING


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