

Comparison of Kit-Build and Scratch-Build Concept Mapping Methods on Memory Retention

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Abstract: Concept map is a useful tool for learners to organize and represent knowledge. Tasks to generate concept maps can be divided into two: one is the segmentation task where parts (called “kit”) of a concept map are extracted; and the other is the structuring task where the extracted elements of the kit are connected and the concept map is built. In the Kit-Build method, a teacher builds a concept map and extracts kits of the concept map, and then provides them to learners. Then, a learner builds a concept map using the kit. In this method, learners do not carry out segmentation tasks but conduct recognition tasks based on the kit. Therefore, it is necessary to examine the influence on learning effect by replacing the two tasks. In this research, we have performed an experiment to compare the Kit-Build method and the usual method - where the learner performs the segmentation tasks and then builds the concept map - to examine the difference on memory retention. 30 subjects were participated in the experiment. As results of ANOVA, the Kit-Build method proved to have memory retention equivalently to the usual method.

Keywords: Concept map, Kit-Build method, memory

Introduction

A concept map is a graphic representation of a semantic structure of propositions based on the relationships among two or more concepts [1]. There are many reports on the effects of concept maps on learners. For example, Morita *et al.* showed that memory is enhanced by presenting the items to be memorized in the form of a concept map [2]. According to Fukuoka and Kasai, the use of concept maps is an effective way to acquire required knowledge in a structuralized form [3].

Furthermore, concept maps are used to evaluate the knowledge of the learners, since it is possible for teachers to examine their externalized knowledge [4-5]. Fukuoka and Iwai have researched the conceptual development of elementary school students between grades four to six [6]. Tanaka and Miyawaki have analyzed the way middle school students associate flowing water and the layers of the earth, by calculating the distance between the nodes from the number of bonds of the nodes [7]. Morita and Sakakibara [8] and Morita *et al.* [9] made a quantitative comparison of the structure of the concept map based on the number of links, and evaluated the conceptual change of the learners before and after the class.

However, in many cases where the learner builds the concept map, the learners freely use the nodes and links, resulting in a variety of expressions. Thus, when considering the evaluation of the acquired knowledge by the learners, it will be a great burden for one teacher to evaluate the numerous varieties of concept maps built by the dozens of learners. For this reason, one way may be for the teachers to prepare the nodes and links beforehand

and provide them to the learners; however, this method may interfere with the free thinking of the learners.

Tasks to generate concept maps can be largely divided into two: one is the segmentation task where the nodes and links (“kit”) of a concept map are extracted from resources such as teaching materials; and the other is the structuring task where the extracted elements of the kit are connected and the concept map is built.

When a concept map is built by one person, the creator simultaneously performs segmentation and structuring tasks. In other words, segmentation and structuring tasks are not clearly differentiated. Furthermore, the segments extracted from the resources differ for each creator. Therefore, comparing multiple concept maps is a large burden. For example, it is not easy to use freely created concept maps as a way to determine the level of understanding of the learners of a class, or to do a comparison or a study among the learners. In this research, we call this type of a mapping method the Scratch-Build method.

In comparison, the Kit-Build method [10] aims to support interaction among the teachers and learners through the concept maps using a computerized system, and differentiates the segmentation and structuring methods between the teachers and learners.

In the Kit-Build method, the teacher performs the segmentation and structuring tasks based on the resource, and builds a concept map that reflects the resource to be studied (called “goal map”). Then, the goal map is broken down to nodes and links to prepare a kit, which are then provided to the learners. In order for the learner to express how he/she understood the content of the resource, after studying the resource (or while studying), the learner builds a concept map (called “learner’s map”) using the kit provided. In this way, actions for “segmentation” are replaced by actions for “recognizing segments”. So the goal map and learner’s map are built using the same nodes and links, making it possible to perform a straight-forward comparison or an evaluation.

However, the learning effects of concept maps made relevant by previous research is based on the premise that the learners were performing the segmentation tasks - fully or in part. On the other hand, in the Kit-Build method, “segmentation tasks” are replaced by “tasks for recognizing segments”, and the necessary and sufficient segments to build a concept map are provided to the learners. Therefore, this replacement may possibly have an influence on learning effects, and the same learning effects as previous methods are not necessarily guaranteed.

In this research, we first conducted an experiment focusing on the “memory of the resources through building a concept map” where the verification of the effects are relatively easy, and compared the effects on the learner’s memory of the Kit-Build method - where the learners recognize the provided segments - and the Scratch-Build method - where the learners themselves conduct segmentation.

1. Kit-Build Method

1.1 Overview of the Kit-Build Method

In the Kit-Build method, the teacher builds a goal map which is the learning target of the resource, and prepares a kit. Using the provided kit, the learner builds the learner’s map and represents how he/she understands the resource.

Since the goal map and learner’s map are built using the same nodes and links, it is easy to directly compare the differences between the maps, and an evaluation or feedback by a computerized system is possible.

1.2 Segmentation and Recognition of Segments

In the Kit-Build method, segmentation is performed by the teacher, and the learners - who do not perform segmentation - recognizes the segments provided by the teacher and structures them. The learning effects of concept maps relevant to date cannot be guaranteed to be applicable to the Kit-Build method.

However, depending on multiple factors such as difficulty of the resource, preexisting knowledge of the learners, and cognitive skills regarding segmentation, it is anticipated that the recognition of the provided segments serve as a scaffold for the learners. For example, when the resource is difficult for the learner and he/she is also not skilled with segmentation, the learner will find it hard to extract segments from the resource, and consequently, structuring will not be possible. In such a case, it is thought that by providing the learner with segments, he/she will be able to recognize the segments by comparing with the resource, and perform structuring tasks as well.

This research keeps in mind such aspects, and will evaluate the factors under much control as possible. To do so, the content of the resource has been limited to the description regarding the hierarchical classification of the element group and the explanatory descriptions of the elements, and an experiment was carried out to see the effects of segmentation and recognition of segments on the memory of mainly the former description.

2. Experiment

2.1 Purpose

The purpose of this experiment is to compare the effects on memory retention of the Kit-Build method, where a learner recognizes segments, and the Scratch-Build method, where a learner carries out segmentation by themselves.

2.2 Hypothesis

In this experiment, there are two hypothesis:

Hypothesis 1) For knowledge related to propositions which the teacher described in the goal map - in other words, propositions which can be built using the kit - the Kit-Build method is more effective than or equal to the Scratch-Built method.

This is based on the assumption that in the Kit-Build method, memorization is carried out more efficiently since segmentation has already been performed by the teacher and therefore the object to be memorized is limited; on the other hand, in the Scratch-Build method, the learner must think of what to memorize while performing segmentation tasks, and therefore is inefficient. It is thought that this trend will be more relevant for knowledge built from complex propositions rather than from a single proposition.

Hypothesis 2) For knowledge regarding propositions not described in the goal map - in other words, propositions which cannot be built using the kit - the Scratch-Build method is more effective than the Kit-Build method.

This is based on the assumption that in the Kit-Build method, memorization is disturbed since the object to be memorized is limited by the teacher and attention to content outside of the limit is weakened; on the other hand, in the Scratch-Build method, the learners themselves must think of the object to memorize, so disturbances do not arise.

2.3 Method

The experiment was conducted over two days. On the first day of testing, the concept map was built and the post test was conducted. On the second day of testing one week later, the delayed test and recognition test were carried out.

2.3.1 Subject

The subjects are 30 third-year students at an engineering university. All of the students have very little experience building concept maps. The 30 students were randomly divided into two groups with 15 students each. One group built the concept map using the Kit-Build method (K-B group), and the other group used the Scratch-Build method (S-B group). Students who were late or absent for the test; who could not complete map building due to system error; or who left blank answers to the tests are not included in the above 30.

2.3.2 Teaching Materials

The teaching material used is titled “The Classification and Usage of Rocks Found in a Certain Region.” We referred to the writing regarding rocks which Morita *et al.* used in their experiment to validate the effects of concept maps on memory learning [2], and included classification of imaginary rocks and their historic and cultural explanations in the writing.

To eliminate the effects of existing knowledge to memory, we used imaginary contents. The reason we included two types of explanations – regarding the classification of rocks, and regarding the history and culture – is to validate the hypothesis we explained in section 2.2 by including the former and leaving out the latter in the goal map. Furthermore, although the former requires segmentation, the burden is not too high and it is possible to create learning materials with a clear framework since there is little fluctuation among the segments that are usually extracted.

2.3.3 Goal Map and Kit

The goal map categorizes the rocks that are mentioned in the writing (Figure 1). There are 17 nodes and 19 links. The kit was created by breaking down the goal map (Figure 2).

2.3.4 Building a Concept Map

In teaching activities, it is common to set a learning goal to make clear how the teaching materials should be understood. For this experiment, the learning goal was to understand the “hierarchical classification of rocks” set forth in the teaching material.

The K-B group was provided with kits (Figure 2). The kit is a set of segments extracted from the teaching material, and is expected to be a catalyst to understand the material.

On the other hand, the S-B group was provided with only the teaching materials, and carried out segmentation freely by themselves. Usually in cases like this, segmentation tends to differ greatly between the subjects. However, in this experiment, a large deviation is not expected since the learning goal is set, and as noted in 2.3.2, the content of the teaching material is limited to two topics.

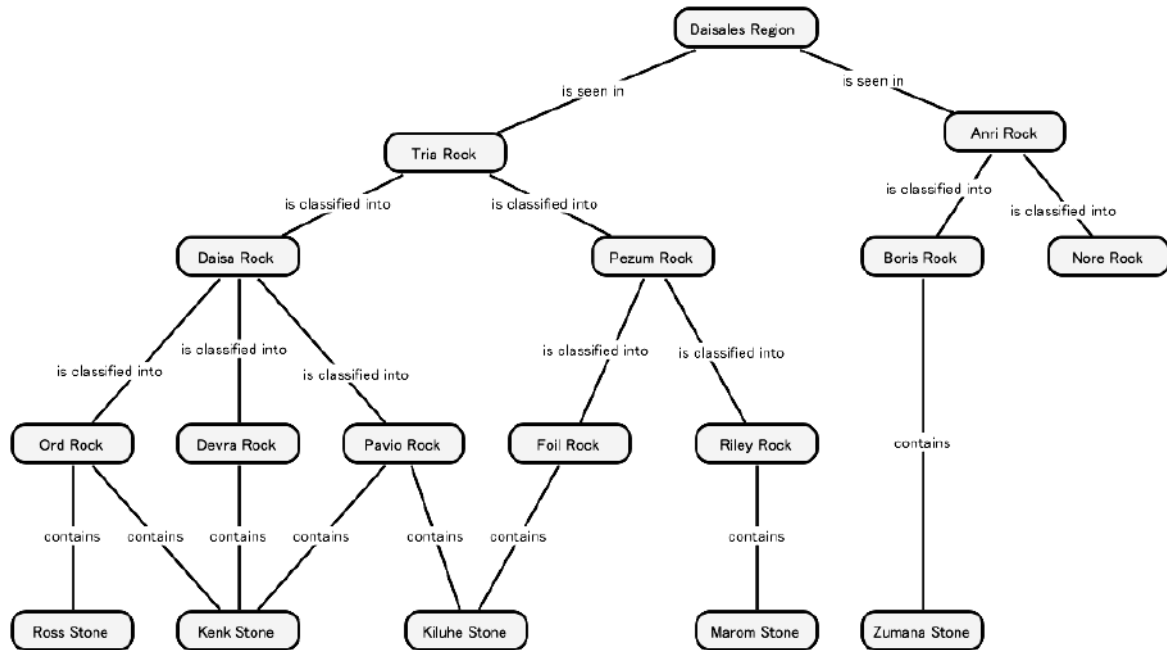


Figure 1: Goal Map

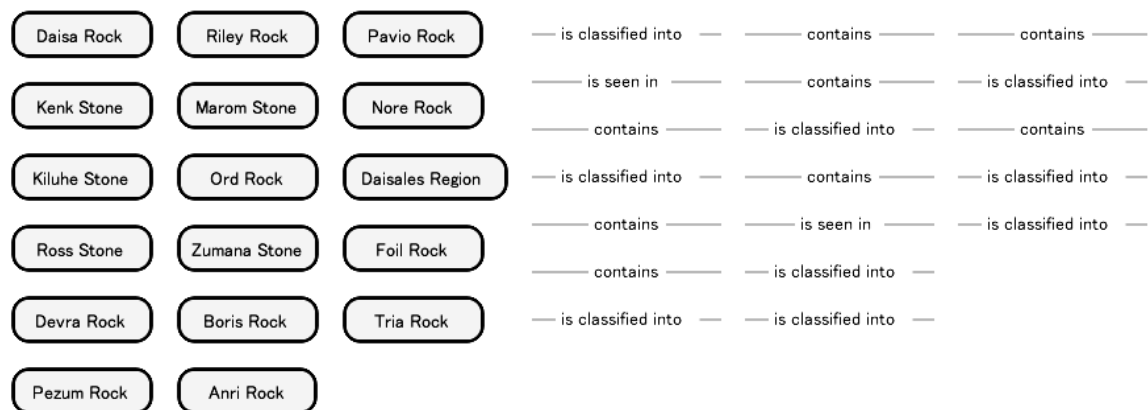


Figure 2: Kit

To build the concept map, we used the “KBmapEditor” [10] concept mapping tool. System operations by the K-B group were limited to moving nodes and links, and connecting links. There was no limit placed on operations by the S-B group, and they were freely allowed to create nodes and links.

2.3.5 Test Questions

To measure the memory of the learners regarding the teaching materials, a fill-in-the-blank question (total 34 questions) composed of a group of keywords based on the teaching material and goal map was prepared. The same questions were used for the post, delayed, and recognition tests, and the order of the questions were re-arranged to minimize the learning effects towards the test. The following three types of questions were prepared based on the hypothesis stated in section 2.2.

(1) Singular answer question regarding the goal map (22 questions)

This question asks to complete a section of the goal map composed of a node- link- node set. The contents are clearly expressed in the teaching material. This type of a question corresponds to the hypothesis 1.

Ex.1) The Ord Rock is a type of a (Disa Rock)

Ex.2) The Boris Rock includes (Zumana Stone)

(2) Multiple answer question regarding the goal map (4 questions)

This question tests the knowledge which can be derived from multiple questions such as those asked in the Singular answer questions. The contents are not clearly expressed. In order to answer this question, the subject will need to look at the larger area of the map composed of multiple sets of node-link-node - instead of just a singular set. This type of a question corresponds to the hypothesis 1.

Ex.1) Rocks categorized as Daisa Rock always include (Kenk Stone)

Ex.2) Rocks belonging to the Pezum Rock include Marom Stone and (Kiluhe Stone)

(3) Singular answer question not related to the goal map (8 questions)

This questions asks to answer questions regarding topics not included in the goal map and thus without a kit, but which are clearly stated in the teaching materials. This question corresponds to the hypothesis 2.

Ex.1) A characteristic of a Kiluhe Stone is that it is (very hard)

Ex.2) Nore Rocks have a characteristic that it (glows in the dark)

2.3.6 Procedures

On the first day of the experiment, a 10-minute explanation was given regarding concept maps and operations of the KBmapEditor using documents on a web page, and the subjects practiced building concept maps. Next, the teaching materials were presented to the subjects, and they were given 5 minutes to study. Finally, after being told that they should focus on creating the concept map with the learning goal of understanding the “hierarchical classification of rocks” and that they would be tested after creating the maps, the subjects were told to build the maps. The S-B group was provided with only the teaching materials; the K-B group was provided with the teaching materials along with the kit; and both groups used the KBmapEditor. The time it took for all subjects to complete creating the concept map was 30 minutes for the K-B group, and 35 minutes for the S-B group. It took 5 more minutes for the S-B group because they had to create the nodes and links by themselves. The amount of time was relatively short, but it was sufficient for all the subjects. After completing the concept map, a 20-minute after-mapping test was conducted to each group at the end of the first day of the experiment.

The second day of the experiment took place one week after the previous test. First, the delayed test was given in 20 minutes. Next, each subject was given 5 minutes to confirm the concept map built by the KBmapEditor on the first day of testing. After checking the concept map, a 20-minute after-confirmation test was given.

2.4 Results and Discussion

The average score and standard deviation of the three tests for both groups are shown in Table 1. For the “Singular answer question regarding the goal map” and “Multiple answer question regarding the goal map”, the K-B group had higher scores. Furthermore, the recognition test tended to have a higher score compared to the post and delayed tests. For the

“Singular answer question not related to the goal map”, the S-B group tended to have a higher score than the K-B group.

As a results of the Two-way Mixed design ANOVA, for the “Singular answer question regarding the goal map” and “Multiple answer question regarding the goal map”, the group factor was insignificant while the test factor was significant ($p<.01$). Furthermore, interaction was not seen. The LSD method was used to assess the differences between the tests, and it showed that the recognition test was significantly higher than the post and delayed tests (each $p<.05$), and there was no significant difference seen between the post and delayed tests.

The result clearly shows that the memory retention of the K-B and S-B groups are the same; memory did not decline after one week; and the short-term memory increased after looking at the concept map, so the hypothesis 1 has been verified.

For the “Singular answer question not related to the goal map”, interaction was seen between the group factor and test factor. Results of the analysis of the interaction showed that in the post test, S-B group had scored significantly higher than the K-B group ($p<.05$), and in the recognition test, the same significant trend was seen ($p<.10$). Furthermore in the S-B group, the test factor was significant ($p<.05$). The LSD method was used to assess the differences between the tests, and it showed that the for the S-B group, scores for the post test was significantly higher than for the recognition test ($p<.05$), and there were no significant differences seen between the post and delayed, and recognition and delayed tests.

It follows from this that immediately after creating the concept map and after looking at the map, the S-B group had a higher memory effect than the K-B group. However, memory declined after one week, and the S-B group had the same amount of memory as the K-B group, so the hypothesis 2 has been verified.

Table 1: Mean and Standard Deviation of Tests

Type of question	Test	K-B group		S-B group	
		Mean	SD	Mean	SD
Singular answer question regarding the goal map	After-mapping	8.13	5.95	4.93	2.86
	Delayed	8.13	6.58	4.53	3.24
	After-confirmation	15.13	6.65	14.6	5.80
Multiple answer question regarding the goal map	After-mapping	2.07	1.24	1.27	0.92
	Delayed	1.67	1.58	1.07	1.07
	After-confirmation	2.60	1.45	2.33	1.45
Singular answer question not related to the goal map	After-mapping	3.53	2.25	5.40	1.67
	Delayed	3.87	1.86	4.27	1.57
	After-confirmation	3.53	2.19	5.00	1.59

3. Conclusion

In this research, we conducted an experiment to compare how two different concept map building methods affect the memory of the learners, with focus placed on the “memory of the resource through building concept maps”. The methods used were the Kit-Build method, where the learners recognize the provided segments, and the Scratch-Build method, where the learners themselves carry out segmentation.

Memory tests were conducted three times; the first was directly after building the concept map; the second was 1 week later; and the last was after reviewing the concept map the learners built themselves. Test results confirmed that 1) there is no difference in memory

between the Kit-Build method and Scratch-Build method regarding contents included in the kit; and 2) for contents not included in the Kit, the Scratch-Build method scored higher. We can see from the above that where segmentation is necessary but the burden is kept low, and where teaching materials with clear structures are used, the Kit-Build method proves effective towards memory as with what has been previously stated regarding concept maps.

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