Analysis of the Relationship Between Metacognitive Ability and Learning Activity with Kit-Build Concept Map

Yusuke Hayashi(✉) and Tsukasa Hirashima

The Department of Information, Hiroshima University, Hiroshima, Japan
hayashi@lel.hiroshima-u.ac.jp

Abstract. Metacognitive ability is one of important ability in learning. If learners can monitor their own cognition and know strategies to control it, they can make their thinking better and get better performance. Concept mapping gathers attention as a tool to facilitate metacognition. This study investigates the relationship between metacognitive ability and learning activity with Kit-build concept map (KB map). In KB map method concept maps cannot be built freely. A teacher forms what he/she wants to teach as a concept map. This is called goal map. And then, this is decomposed into separated nodes and likes. These parts are provides to learners and they make a concept map with the parts to represent their understanding. Like this, the method doesn't allow freedom to build concept maps. Instead, a teacher can grade maps of learners with consistency as the degree of the same parts as the gal map. The degree can be an important indicator of understanding of learners. Metacognitive ability can be decomposed into three sub abilities: metacognitive monitoring, control and knowledge. This study investigates correlation between these sub abilities and score of map. The correlation presents, in learning with KB map, which sub ability affect map score, that is, understanding of learner. The result shows there is the correlation between metacognitive control and map scores. From this result, it can be considered that Kb map helps learners to monitoring their cognition.

1 Introduction

Metacognition has received considerable attention in the research area of learning. Flavell 3 and Brown 2 have popularized the concept in the area of and cognitive psychology and educational psychology. Although the definition of it is not necessarily fixed in these fields metacognition is defined in terms of metacognitive knowledge and metacognitive skills. Many studies show the relation between metacognition and learning.

Concept maps are described as a metacognitive tool 4. Concept maps are graphic representations of a semantic structure of propositions based on the relationships among two or more concepts. There are many reports on the effects of concept maps on learners. As a method of concept map building there is Kit-build concept map 510. Although general concept map building allows learners to make nodes and links freely, this method provides learners with nodes and links (kit). Learners only use the kit to build concept map.

S. Yamamoto (Ed.): HIMI 2015, Part II, LNCS 9173, pp. 304–312, 2015.
DOI: 10.1007/978-3-319-20618-9_30

This study investigates the relation between meta-cognition and KB map. In the next section, the framework and the characteristic of KB map. Section 3 explains the experiments conducted in this study. Section 4 show the results of the experiments and give consideration to the result. Finally Sect. 5 concludes this paper.

2 Kit-Build Concept Map

Kit-build concept map is based on that the task to make concept maps is divided into two sub-tasks: segmentation task and structuring task 4. In the segmentation task parts of a concept map are extracted from learning resources. In the structuring task the parts are integrated into a concept map. One of the characteristics of KB map is that learners are given a set of parts for a concept map and then re-build the concept map from the parts. In this process, segmentation task is replaced with recognition task of the given parts. Parts are made from a concept map prepared by teacher. Such a concept map is called *goal map*. Parts are made by decomposing a goal map.

Figure 1 illustrates an example of a goal map. Teachers make goal maps as a representation of the structure of what they want learners to learn. Figure 2 illustrates an example of parts. It is call as *kit*. Although, in general concept map building, learners are required to extract parts from learning resources, in KB map building learners just recognize the parts.

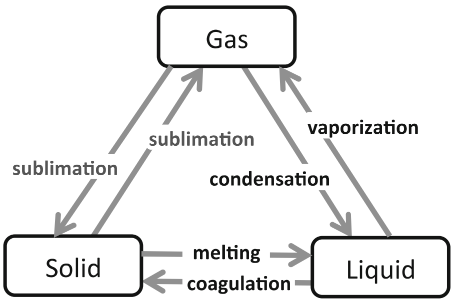

Fig. 1. An example of goal map

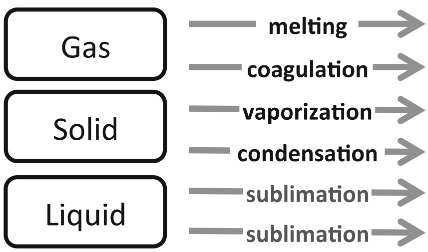

Fig. 2. An example of kit

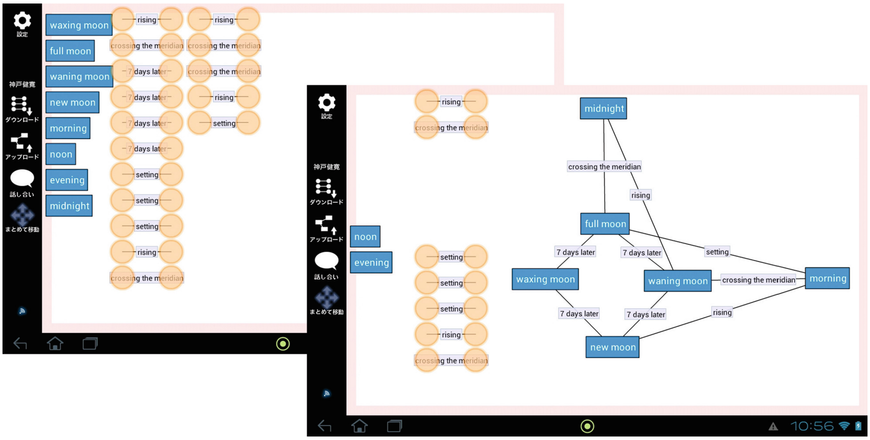

Fig. 3. The screenshot of KBeditor on tablet computers

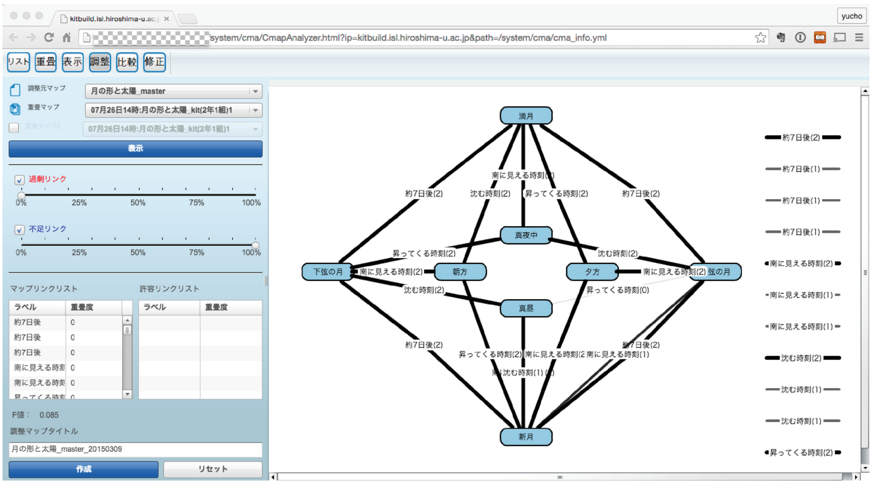

Fig. 4. A screenshot of KBanalyzer

In KB map building sub-task is different from general concept map building. However, there is no difference in memory holding between the KBmap and general concept map building regarding contents included in the kit 4.

KBmap system for building KB maps and analyzing them has developed 9. The system is composed of two client systems: *KBmap editor* and *KBmap analyzer*, and the server system *KBmap DB*. KBmap editor works on desktop and tablet computers. Especially, KBmap editor for tablet is portable and can be used not only in computer rooms but also in normal classroom. Figure 3 shows the screenshot of KBeditor on tablet computers. KBmap analyzer works on web browsers. Kb maps made by students are collected into KBmap DB and teachers can access to the data to analyze it on. Figure 4 shows a screenshot of KBanalyzer.

KBmap system is actually used in the classroom in an elementary school and junior high school. The practical uses show the advantages of KB maps on learning effect 9, formative evaluation for improvement of lesson 11 and collaborative learning support 6.

3 Experiments

This study conducts two experiments to investigate the relationship between kit-build concept maps and meta-cognition. In each experiment subjects are measured their metacognitive ability with a metacognition scale and make a concept map with kit-build approach.

3.1 Measurement of Meta-cognition

This study uses the adults' metacognition scale constructed by Abe and Ida. This is constructed based on Metacognitive Awareness Inventory that is composed as measure Metacognition 8. Abe and Ida translated this inventory into Japanese and modified it for adults 1. This modified inventory includes 28 items to measure meta-cognitive knowledge, monitoring and control. Eight items are related to meta-cognitive knowledge, nine items are related to meta-cognitive monitoring and eleven items are related to meta-cognitive control.

3.2 Experiment 1

This experiment uses kit-build concept maps about animals and plants. Figures 5 and 6 show these kit-build concept maps. Subjects are 23 university students and construct these kit-build concept maps with their knowledge.

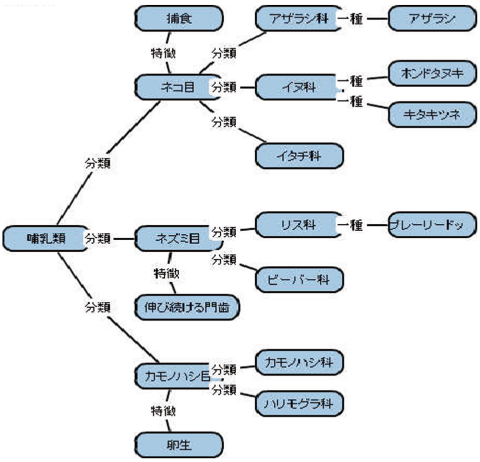

Fig. 5. Goal map used in experiment 1 (animals)

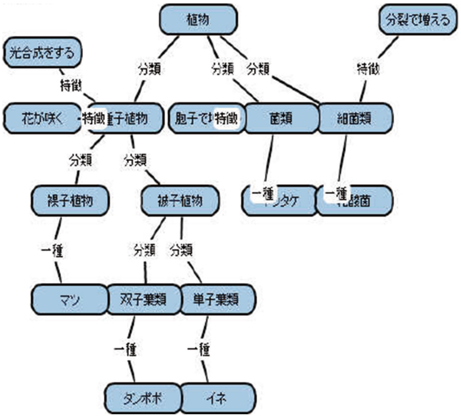

Fig. 6. Goal map used in experiment 1 (plants)

3.3 Experiment 2

This experiment uses a kit-build concept map about climate. Figure 7 shows the kit-build concept map. Subjects are 25 graduate school students. The characteristic of this experiment is that subjects build the concept map while reading a document about the topic. Firstly the subjects have practice to build concept map with another kit-build concept map within five minutes and then they build a concept map within 40 min. In addition to that, they build the same kit-build concept map one week later.

4 Results and Discussion

Figures 8, 9, 10 and 11 illustrate correlation coefficients between maps score and metacognitive ability. The score indicates degree of similarity between a map made by a subject (subject map) and the goal map. It takes the value of 0 to 1. If the score is 1, it means the subject map is completely same as the goal map. The score is calculated by the following equation:

$$mapscore = \frac{the\,number\,of\,the\,correct\,propositions\,in\,a\,subject\,map}{the\,number\,of\,the\,propositions\,in\,the\,goal\,map}$$

Tables 1, 2, 3 and 4 shows correlation coefficients of maps and factors of meta-cognitive ability: meta-cognitive monitoring, control, knowledge and total. As shown in the table, there are mainly significant difference in metacognitive control.

In Experiment 2 there is significant difference only in the delayed kit-build concept map building. It can be considered that this is caused by ceiling effect. In this map building the average score is 0.879 and the standard deviation is 0.137. If there is correlation between map score and meta-cognitive ability in this map, it would be difficult to find significant difference.

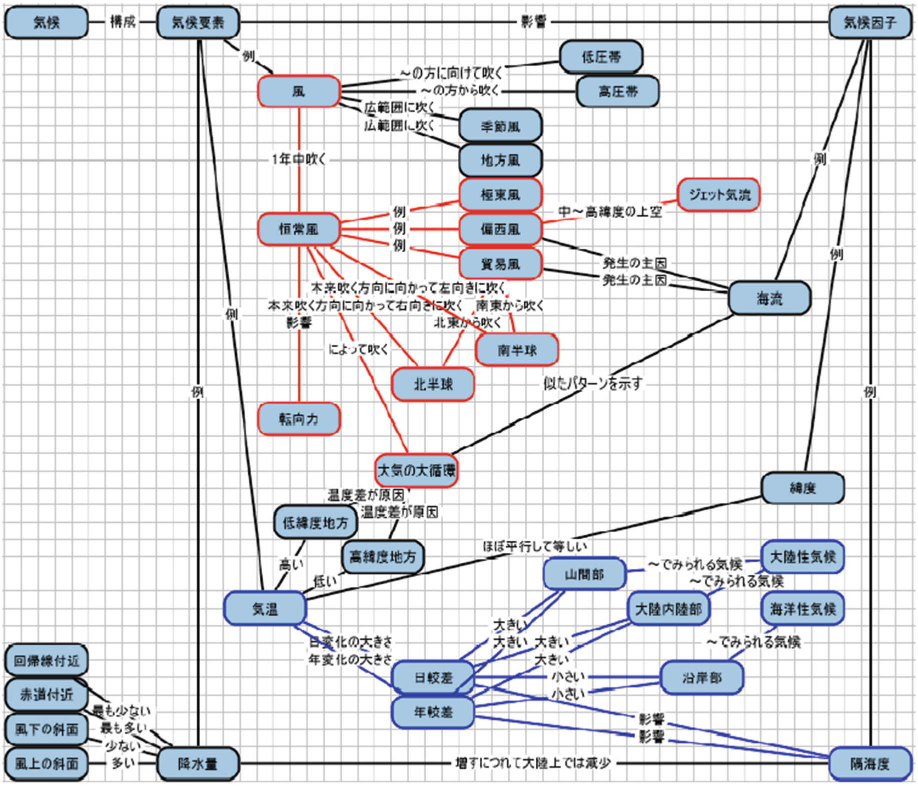

Fig. 7. Goal map used in experiment 3

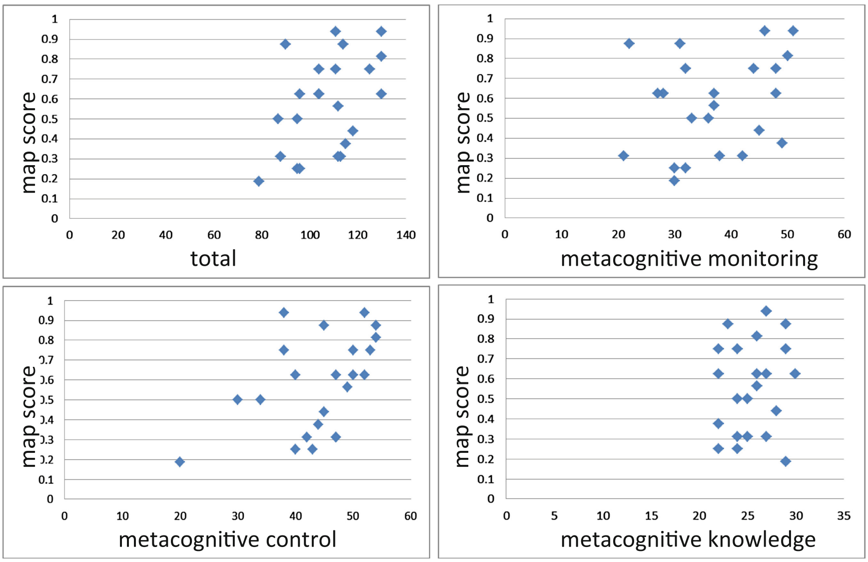

Fig. 8. Results of experiment 1(animals)

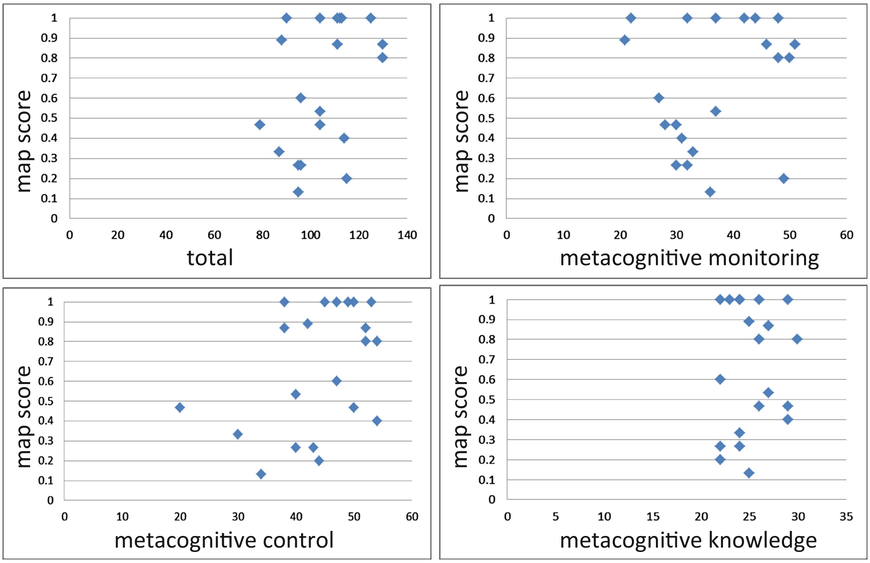

Fig. 9. Results of experiment 1 (plants)

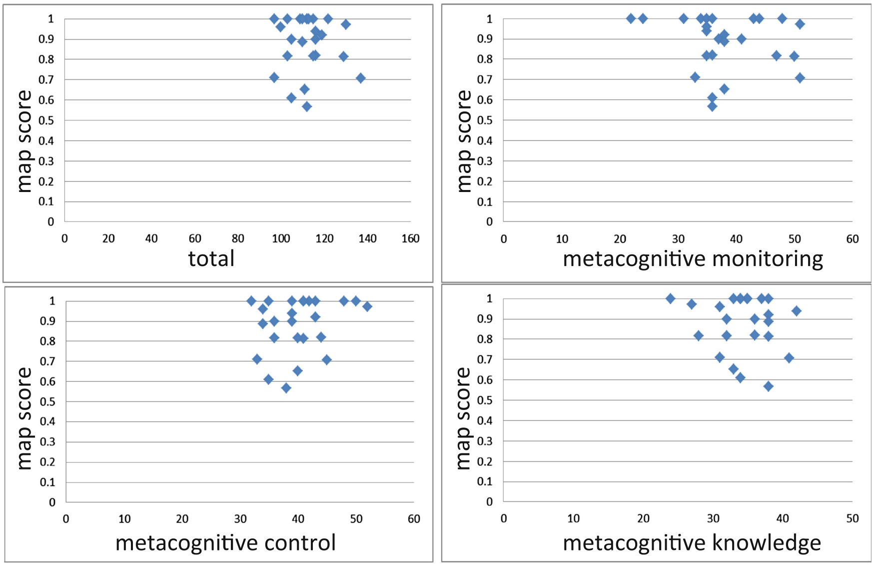

Fig. 10. Results of experiment 2 (map building)

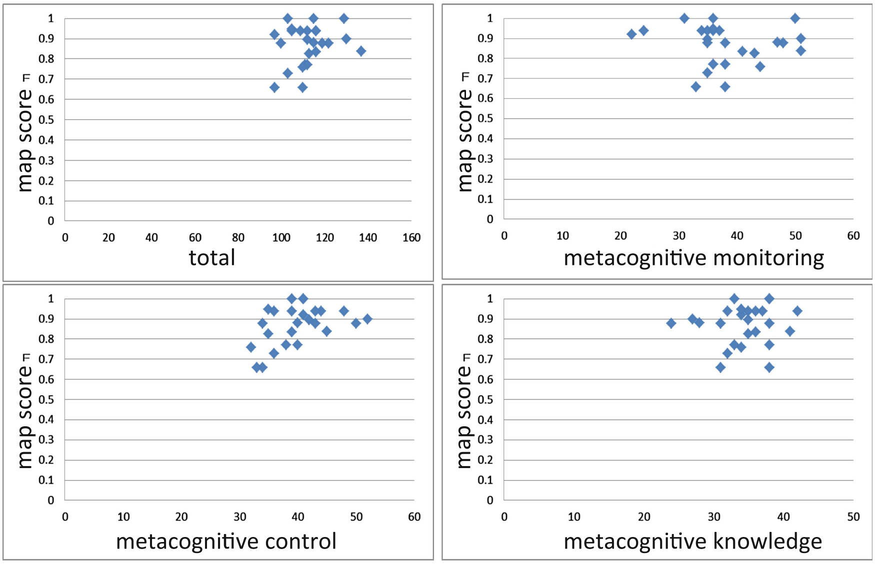

Fig. 11. Results of experiment 2 (delayed map building)

Table 1. Results of experiment 1 (animals)

	Monitoring	Control	Knowledge	Total
Correlation coefficient	0.276	0.464**	0.176	0.468**
p-value	0.203	0.026	0.421	0.024

$r_{0.05} = 0.396$

Table 2. Results of experiment 1 (plants)

	Monitoring	Control	Knowledge	Total
Correlation coefficient	0.201	0.399**	0.138	0.381
p-value	0.359	0.059	0.531	0.073

$r_{0.05} = 0.396$

Table 3. Results of experiment 2 (map building)

	Monitoring	Control	Knowledge	Total
Correlation coefficient	-0.142	0.242	-0.142	-0.040
p-value	0.347	0.105	0.345	0.791

$r_{0.05} = 0.380$

Table 4. Results of experiment 2 (delayed map building)

	Monitoring	Control	Knowledge	Total
Correlation coefficient	-0.088	0.443**	0.089	0.206
p-value	0.562	0.002	0.555	0.169

$r_{0.05} = 0.380$

From these results, in building kit-build concept map, meta-cognitive control can be potentially related to map score. It is considered that this is caused by replacement of segmentation task in scratch-build concept map building with recognition task of kit in kit-build concept map building. This change of task decreases the load of meta-cognitive monitoring and fosters meta-cognitive control.

5 Conclusion

This study investigates the effectiveness of kit-build concept map building in terms of meta-cognition with three experiments. From the results it can be considered that there is the potential that only meta-cognitive control skill influences to kit-build concept map building. It can be considered that it is related to the characteristic of KB map. In KB map segmentation task is replaced with recognition of parts. This reduces the load of meta-cognitive monitoring, therefore only correlation between map score and metacognitive control. Further investigation is necessary to verify this consideration as future work.

References

1. Abe, M., Ida, M.: An attempt to construct the adults' metacognition scale: based on metacognitive awareness inventory. J. Psychol. Rissho Univ. **1**, 23–34 (2010). (in Japanese)
2. Brown, A.L.: Knowing when, where, and how to remember: a problem of metacognition. In: Glaser, R. (ed.) Advances in instructional psychology, vol. I. Erlbaum, New Jersey (1978)
3. Flavell, J.H.: Metacognitive aspects of problem solving. In: Resnick, L.B. (ed.) The Nature of Intelligence, pp. 231–235. LEA, Hillsdale (1976)
4. Funaoi, H., Ishida, K., Hirashima, T.: Comparison of kit-build and scratch-build concept mapping methods on memory retention. In: Proceedings of ICCE 2011, pp. 539–546 (2011)
5. Hirashima, T., Yamasaki, K., Fukuda, H., Funaoi, H.: Framework of Kit-Build Concept Map for Automatic Diagnosis and Its Preliminary Use, RPTEL(Research and Practice in Technology Enhanced Learning), 1 (2015) (accepted)
6. Nomura, T., Hayashi, Y., Suzuki, T., Hirashima, T.: Knowledge propagation in practical use of kit-build concept map system in classroom group work for knowledge sharing. In: ICCE 2014 Workshop Proceedings, pp. 463–472 (2014)
7. Novak, J.D., Gowin, D.B.: Learning how to learn. Cambridge University Press, New York (1984)
8. Schraw, G., Dennison, R.S.: Assessing metacognitive awareness. Contemp. Educ. Psychol. **19**, 460–475 (1994)
9. Sugihara, K., Nino, Y., Moriyama, S., Moriyama, R., Ishida, K., Osada, T., Mizuta, Y., Hirahima, T., Funaoi, H.: Interactive use of kit-build concept map with media tablets. In: IEEE Seventh International Conference on Wireless, Mobile and Ubiquitous Technology in Education, pp. 325–327 (2012)
10. Yamasaki, K., Fukuda, H., Hirashima, T., Funaoi, H.: Kit-build concept map and its preliminary evaluation. In: Proceedings of ICCE 2010, pp. 290–294 (2010)
11. Yoshida, K., Sugihara, K., Nino, Y., Shida, M., Hirashima, T.: Practical use of kit-build comcept map system for formative assessment of learners' comprehension in a lecture. In: Proceedings of ICCE 2013, pp. 892–901 (2013)