Instantaneous Assessment of Learners' Comprehension for Lecture by Using Kit-Build Concept Map System

Kan Yoshida[1,*], Takuya Osada[3], Kota Sugihara[3], Yoshiaki Nino[3], Masakuni Shida[2], and Tsukasa Hirashima[3]

[1] Faculty of Engineering, Hiroshima University, Japan
yoshidak@lel.hiroshima-u.ac.jp
[2] Science Research Department, Attached Elementary School of Hiroshima University, Japan
mshida@hiroshima-u.ac.jp
[3] Graduate School of Engineering, Hiroshima University, Japan
{osada,sugihara,nino,tsukasa}@lel.hiroshima-u.ac.jp

Abstract. This paper described a practical use of kit-build concept map (KBCM) in science learning class in an elementary school in order to evaluate learners' understanding ongoing the teaching. The responsible teacher of the class reported that the information provided from KBCM is useful to decide complementary teaching ongoing class and improve lesson plan of the next class. We have confirmed that the map scores in KBCM have significant correlation with the scores of standard test of science learning. This case study suggests that KBCM is promising tool to estimate learners' understanding in classroom.

Keywords: kit-build, concept map, instantaneous assessment.

1 Introduction

It is usually difficult for a teacher to estimate learner's comprehension for his/her lecture, although it is indispensable to complement and improve his/her teaching [1]. Concept map [2] is promising way to assess learners' comprehension but it is usually difficult for learners to build and hard for teachers to diagnose. Kit-build concept map is a new framework to build and diagnose concept maps [3,4,5,6]. In this paper, we report a practical use of kit-build concept map system (KBCM) in science lessons in an elementary school as a realization of instantaneous assessment of learners' comprehension for the contents of teaching. In KBCM, a learner makes a concept map by assembling provided parts (we call this method "kit-build"). The parts, then, are generated by decomposing an ideal concept map that is prepared by a teacher as the goal of his/her teaching. Because both the maps made by learners (learner map) and the ideal map made by the teacher (goal map) are composed of the same components, it is possible to compare or overlap them. KBCM provides the teacher with information about learners' comprehension as a map made by overlapping all learner maps (group

* Corresponding author.

S. Yamamoto (Ed.): HIMI/HCII 2013, Part III, LNCS 8018, pp. 175–181, 2013.

map), differences between the group map and the goal map. The teacher is also able to check each learner map and compare it with the group map, goal map or another learner map.

Through the practical use of KBCM, the responsible teacher of the classes judged that the information provided from KBCM was useful to grasp learners' comprehension and the teacher was able to improve his ongoing and the next teaching based on the information. Then, we found that there was positive correlation between scores of leaner maps calculated by comparing the goal map and scores of a standard assessment test as for learners in the first class. These results suggest that KBCM is a promising approach to realize instantaneous assessment of learners' comprehension for a lecture. In this paper, the practice and results are reported.

2 Procedure of the Practice

Teaching with KBCM was carried out for two classes in the sixth grade in an elementary school. There were 36 learners in the first class and 40 learners in the second one. The procedure of the teaching was as follows.

1. The teacher selected a topic of the lesson and made a teaching plan for the topic. In this practice, the topic is "decomposition of starch made by photosynthesis in leaves into sugar, and transfer of water-melted sugar through stalk". The teacher planned to use two class times (one class time is 45 minutes) for this topic. An experiment to confirm "decomposition of starch in a plant" was included.
2. The teacher creates a concept map that expresses the goal of comprehension of the lessons. The goal map is shown in Figure.1.
3. The teacher taught the topic at the first class.
4. In the middle of the class, the teacher required the learners to make a map with KBCM in order to confirm their understanding. Leaner interface of KBCM is implemented on media tablets. Then, each learner made his/her map with one media tablet. It took ten minutes. When learners made their maps, they walked around freely and talked each other. This is a way to use KBCM in collaborative learning situation [7]. The scene is shown in Figure 2. This is an important benefit to implement KBCM with media tablet [8]. After this collaboration, the learners had improved their understanding.
5. Learner maps were sent to KBCM server through wireless LAN and diagnosed by overlapping and comparing. By comparing the group map with the goal map, it is possible to generate a kind of group map that is composed of lacking links in the learner maps. Figure 3 is the group map composed of the lacking links we obtained in the first class. This map can be generated by comparing the group map and goal map, and then, displaying only lacking links. The bracketed numbers indicate the number of learner maps that don't include the corresponding link. This map informed the teacher that the learners tended to overlook "photosynthesis" link between "leaves" and "starch" (that is, twenty learners in the class could not linked correctly) and "transferable" link between "stalk" and "sugar" (that is, 19 learners could not linked correctly).

6. The teacher examined the information provided from KBCM and found weak points of learners' comprehension of the first class. As mentioned in above step, the teacher found that "photosynthesis" link between "leaves" and "starch" and "transferable" link between "stalk" and "sugar" were weak point of the learners. Therefore, the teacher made supplemental explanation based on the information.
7. At the end of the class, the teacher required the learners to make a map to confirm their final comprehension.
8. The teacher modified the lesson plan of the second class immediately based on the results of the first class in order to emphasis the links that the learners overlooked in the first class. Then, by using the modified lesson plan, the teacher conducted the class.

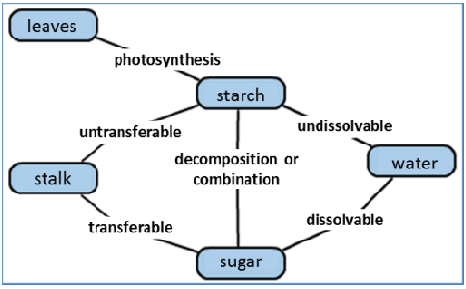

Fig. 1. Goal Map

Fig. 2. Learners Building Concept Maps in Classroom

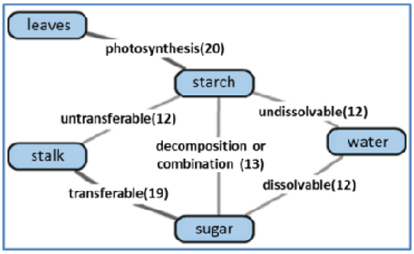

Fig. 3. Group Map Composed with Lacking Links

3 Analysis of the Results

3.1 Comparison Map Scores with Standard Test Scores

The score of the leaner map is calculated by (number of correctly connected links in a learner map) / (number of links in the goal map). It represents the degree of coincidence of learner's map and goal map, and takes the value of 0 to 1. We have compared the learner's map scores with learner's standard assessment test scores of science that were carried out to evaluate general ability of science.

In the first class, average 1st map score was 0.614 (SD=0.245). As for these learners, the correlation coefficient between the scores of the learner maps and the scores of the standard assessment test of science was 0.545. The result was statistically significant (N=36, p=0.0004). This means that higher ability learners in science made better concept maps. It suggests that the map quality would reflect learner's comprehension.

In contract, as for the second class learners, their average 1st map score was 0.792 (SD=0.229) and the correlation coefficient was 0.174. In this class, even learners with low ability in science could understand the lesson enough thanks to the effect of the improvement based on the information provided from KBCM. That caused a celling effect, and it made the correlation coefficient low. The scatter grams of Figure 4 and Figure 5 show the relationship between map scores and science grade of each class.

The celling effect is shown on the scatter gram of the second class. As for the second class, the average of map scores is 0.792 and the standard deviation is 0.229. The sum of these is 1.02. This is higher than the maximum value map score can take. Thus, the ceiling effect of the second class is statistically confirmed.

As for the second maps, similarly to the first ones, there was statistically significant correlation in the 1st class, but wasn't in the 2nd class because of the ceiling effect.

Table 1. Correlative Coefficients Between Map Scores and Standard Test Scores

	1st class	2nd class
1st map score	0.545 (p=0.0004)	0.174 (p=0.283)
2nd map score	0.444 (p=0.005)	-0.219 (p=0.174)

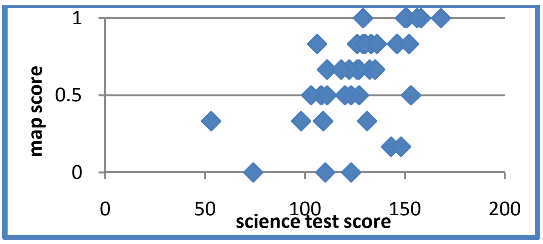

Fig. 4. Standard Test and 1st Map Scores in the 1st Class

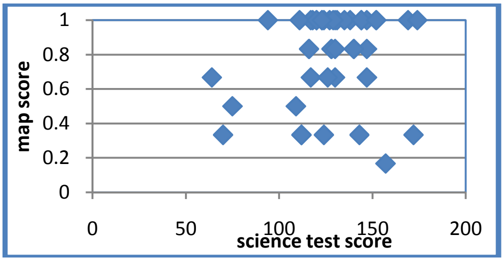

Fig. 5. Standard Test and 1st Map Scores in the 2nd Class

3.2 Internal-Class Improvement

Figure 6 shows the user interface of the system that the teacher used to check learners' comprehension. Right side is the area to show several kinds of group maps and left side is the area to modify the group map. It is possible to show or hide lacking links and excess links of all learners in the group map. Excess link is a link that is contained in the learner's map but isn't contained in the goal map. It represents the learner's misunderstanding. Contrary, lacking link is a link that isn't contained in the learner's map but is contained in the goal map. It represents where the learner doesn't understand. By moving the sliders on the left side of the interface, it is possible to view only lacking links or excess links of large numbers.

The teacher noted that the system brought meaningful information that the teacher didn't expected, and he reported that it is impossible to gasp such understanding situation of learners without the system. Table 2 shows the number of lacking links in each class and map building time. The teacher checked lacking links in first maps, and conduct complementary explanation for the learners to promote the understanding of the links. In this practice, the teacher modified the visualized links of the group map and showed it the learners directly when he gave supplementary teaching in order to focus their attention. The learners also paid special attention to the shown map and links and accepted they were reflected their comprehension.

3.3 Cross-Class Improvement

The teacher not only conducted supplementary teaching based on the information he grasp from the group maps, but also modify the lesson plan of the second class. Because the second class was scheduled just after the first class, he didn't change the main story or materials but take care to emphasis and explain politely concerning the lacking links. Of course, there was explanation related to the links but the teacher judged that the explanation was not enough.

Table 3 shows averages of science test scores and map scores of each class. The average map scores of the second class were higher than that of the first class. The difference is statistically significant. Besides, there is no significant difference between averages of science test scores of each class. These facts suggest that the improvement of the lesson was effective.

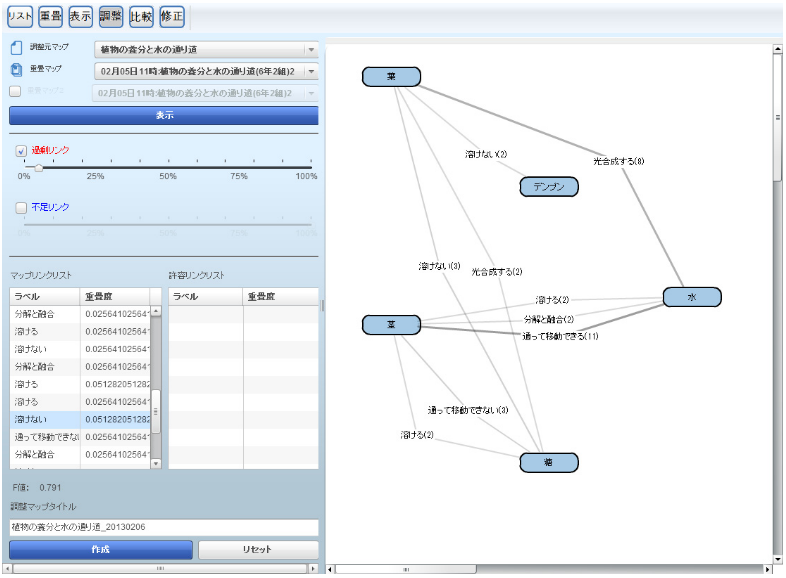

Fig. 6. User Interface for Teacher to Check Learners' Understanding

Table 2. Lacking Links

	1st class 1st map	1st class 2nd map	2nd class 1st map	2nd class 2nd map
photosynthesis	20	11	15	4
transferable	19	13	11	0
untransferable	12	5	9	1
decomposition or combination	13	6	7	0
dissolvable	12	7	6	0
undissolvable	12	7	3	0

Table 3. Map Scores of 1st and 2nd class

	1st class	2nd class
Average Science test score （ /200）	126.3	127.2
Average 1st map score （ /1）	0.614	0.792
Average 2nd map score (/1)	0.791	0.979

4 Conclusion Remarks

The teacher thinks that assembling a concept map with Kit-Build system and answering to a mini test has the almost same meaning as a method to check students' understanding, and that the former is superior because of its automatic and real-time analysis. Besides, positive evaluations were gained from the students by the questionnaire. From these and the analysis of the results, we conclude that the use of Kit-Build system was useful as a method to check students' understanding. To extend the size of practice and confirm the usefulness of KBCM are our important future wok.

References

1. Royce Sadler, D.: Formative assessment and the design of instructional systems. Instructional Science 18, 119–144 (1989)
2. Novak, J.D., Gowin, D.B.: Learning how to learn. Cambridge University, New York (1984)
3. Yamasaki, K., Fukuda, H., Hirashima, T., Funaoi, H.: Kit-Build Concept Map and Its Preliminary Evaluation. In: Proc. of ICCE 2010, pp. 290–294 (2010)
4. Hirashima, T., Yamasaki, K., Fukuda, H., Funaoi, H.: Kit-build concept map for automatic diagnosis. In: Biswas, G., Bull, S., Kay, J., Mitrovic, A. (eds.) AIED 2011. LNCS, vol. 6738, pp. 466–468. Springer, Heidelberg (2011)
5. Funaoi, H., Ishida, K., Hirashima, T.: Comparison of Kit-Build and Scratch-Build Concept Mapping Methods on Memory Retention. In: Proc. of ICCE 2011, pp. 539–546 (2011)
6. Kouta, S., Takuya, O., Tsukasa, H., Hideo, F., Shinsuke, N.: Experimental Evaluation of Kit-Build Concept Map for Science Classes in an Elementary School. In: Proc. of ICCE 2012. Main Conference E-Book, pp. 17–24 (2012)
7. Hirashima, T., Yamasaki, K., Fukuda, H., Funaoi, H.: Diagnosable Concept Map toward Group Formation and Peer Help. In: CSCL 2011, pp. 880–881 (2011)
8. Sugihara, K., Nino, Y., Moriyama, S., Moriyama, R., Ishida, K., Osada, T., Mizuta, Y., Hirashima, T., Funaoi, H.: Implementation of Kit-Build Concept Map with Media Table. In: Proc. of WMUTE 2012, pp. 325–327 (2012)