Kit-Build Concept Map and Its Preliminary Evaluation

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Abstract: In this paper, we have described Kit-Build method as an approach to realize automatic assessment of a concept map. In Kit-Build method, an ideal concept map (goal map) is prepared by an expert of a target domain at first, and parts are generated by decomposing the goal map. The parts are provided to a learner, and then the learner rebuilds a concept map (learner map) by connecting the parts. It would be easy to diagnose the maps by comparing the goal map and learner map because the same parts are used in them. We have already designed and developed a learning environment with the Kit-Build method. An experimental evaluation of the learning environment is also reported.

Keywords: Concept Map, Automatic Assessment, Kit-Build Method

Introduction

The concept map is a tool that helps to organize knowledge for meaningful learning [1]. By building concept maps, learners are promoted to confirm their knowledge by themselves and to comprehend the knowledge deeply. The concept maps built by learners are also useful for teachers to examine the students' understandings [2,3]. Assessment of concept maps built by learners, however, remains as a big issue to realize educational interaction through the concept map. A learner sometimes fails to build an adequate concept map and then it is often difficult for the learner to be aware of the incompleteness. Therefore it is necessary to support the learner to find and correct the errors. It is, however, almost impossible for a teacher to check several concept maps built by several learners at a time. Therefore, from the viewpoint of technology-enhanced learning, several investigations have already addressed the automatic assessment of learners' concept maps and providing appropriate feedback [4-7]. Basic approach to realize the assessment is to compare the learner's and the expert's concept maps. Most of the investigations have addressed the automatic assessment and paid special attention to handle the cases where learners have misspelled a concept or they have used a synonym or a concept related to the appropriate one based on natural language processing techniques.

In this paper, we have proposed "Kit-Build method" as an alternative approach to realize automatic assessment of concept maps. In the Kit-Build method, an ideal concept map (goal map) is prepared by an expert of a target domain at first, and parts are generated by decomposing the goal map. The parts are provided to a learner, and then the learner is required to rebuild a concept map (learner map) by connecting the parts. In this method, diagnosis the maps by comparing the goal map and learner map becomes very easy because the same parts are used among them. This method makes the following matters possible for a teacher and learners: (i) getting the differences between a goal map and a learner map, (ii) getting the differences between each of learner maps, and (iii) getting the concept map of a group which is generated by overlaying learner maps including the group. The group map can also be compared with other maps. The results of the diagnosis enable the environment

to indicate inadequate portions in the concept map of individuals or group. Additionally, since it is possible to evaluate the similarity of the concept maps of each learner, the results are useful to formulate collaborative learning group.

We have already designed and developed a system where learners can build concept maps, the system diagnoses the built map, and the system gives feedback based on the diagnosis. In this paper, an implementation of Kit-Build method and an experimental use and evaluation of the implementation are reported.

1. Implementation of Kit-Build Method

We have designed a practical flow to build concept maps with the Kit-Build method. The flow is compose of four main phases 1) Goal map building, 2) Learner's map building, 3) Goal map modification, and 4) Learner's map modification (details of the flow is not described in this paper because of page limitation). We have already developed a system based on this flow. The system is called as "CmapSystem". It is a web application with two client systems ("CmapEditor" and "CmapAnalyzer") and a server system ("CmapDB"). Interfaces of CmapEditor and CmapAnalyzer are shown in Figures 1 and 2, respectively (because only Japanese version has been implemented, the words in figures are translated into English).   CmapEditor has functions to make a goal map, a kit, and a learner's map. This system has been implemented by Java (version 1.6). CmapAnalyzer has functions to gather learner's maps, adjust a goal map, and revise a learner's map. This system has implemented by Flash and supports version Flash Player 10. CmapDB has a function to store and share maps. This system was developed by Ruby (version 1.8.6) on Rails (version 1.2.3) and MySQL (version 5.1.30). Experimental use of CmapSystem is reported in Section 2.
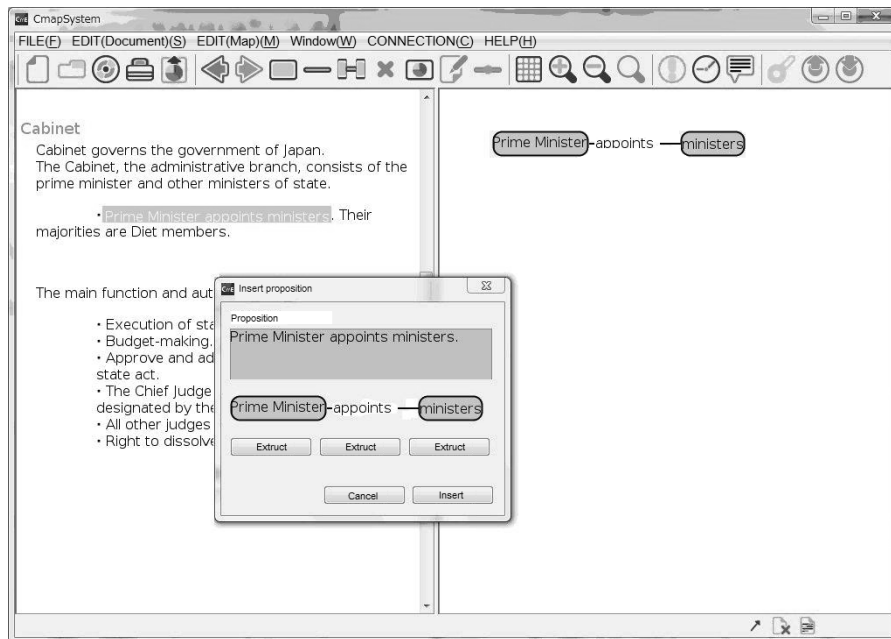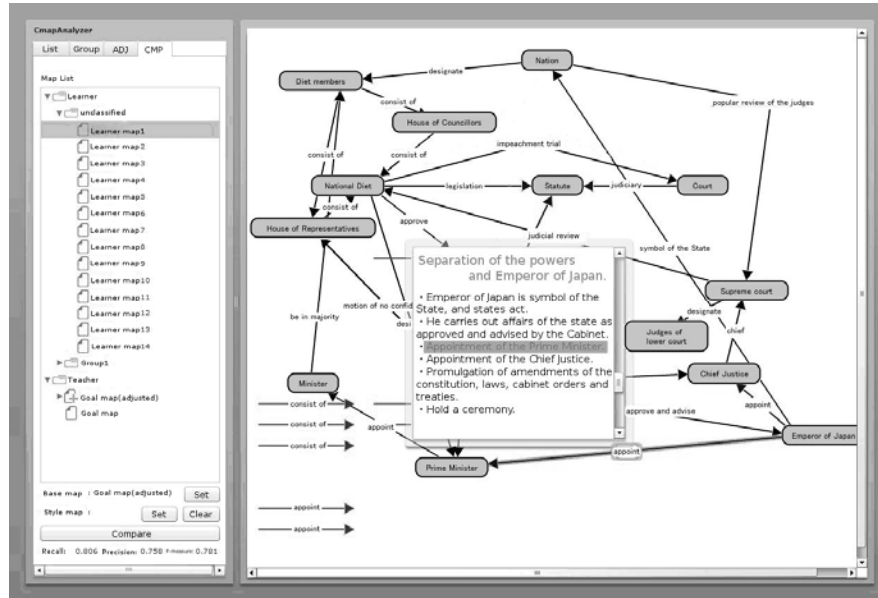

Figure 1: CmapEditor

Figure 2. CmapAnalyzer

2. Experimental Evaluation

2.1 Purpose of the Experiment

The purpose of this experimental use of CmapSystem is to examine whether it is possible to interact between teachers and learners through the concept maps or not. In this experimental use, since learning materials are prepared by the authors of this paper, we (the authors) played the role of teachers. Practical use by teachers is one of our important future works. The interaction is composed of the following 4 phases: (1) Goal map building (2) Learner map building, (3) Goal map modification, and (4) Learner map modification. Because (1) is an activity only for the teachers, we tried to confirm (2)-(4).We have already carried out three experimental uses. In the first experiment, 12 university students used the system until the third phase. In the second, 15 teachers of K12 used the system in the role of learners until the third phase. In the third experiment, 30 university students used the system until the fourth phase. The results of these experiments are almost similar, only the third experiment is reported in this section.

2.2 Experiment Procedure

The experiment was conducted for two days. At the first day, the following procedures were carried out. At first, we provided the subjects with a learning material of "separation of powers under the Japanese Constitution", and requested them to read the content in twenty minutes. All subjects have learned the content at least once in high school or university. Next, we explained "concept map" and "method of making the concept map by the system" in ten minutes. Afterwards, concept map of the "separation of powers" was made by the subjects in twenty minutes with the system. During the phase of the learner map building, the learning material was available in the system. After that phase, the learner maps were gathered through online and analyzed by CmapAnalyzer. At first, by overlaying the learner maps, a group map was generated. By comparing the group map with the goal map, we checked and adjusted the goal map. At the second day, the differences between the adjusted goal map and each learner map were given to each learner. Then, each learner is required to improve their maps individually for 20 minutes. Afterwards, the subjects answered their questionnaires. In the second day, 26 subjects attended this experiment because four remaining subjects made a complete learner map.

Table 1. Results of the Questionnaires

	Questions	Strongly agree	Agree	Disagree	Strongly disagree
(1)	Building the concept map was useful to understand the learning material.	17	10	3	0
(2)	Kits were helpful to build the concept map.	19	8	3	0
(3)	There are enough kits to build the concept map.	4	16	8	1
(4)	Building the concept map that represent your understanding was easy	6	9	15	0
(5)	The concept map you built was appropriate.	3	16	10	1
(6)	The feedback for the concept map was appropriate.	14	9	1	2
(7)	Activity to improve the concept map was useful to understand the learning material.	11	14	1	0

2.3 Results of the Activities

The document of the "separation of powers" composed of 1101 Japanese characters and 6 paragraphs. The goal map consisted of 16 nodes and 33 links. Therefore, a subject was requested to build a learner map with 49 kits. Thirty learner maps were built by 30 subjects. CmapAnalyzer detected 63 excess links (2.1 links in average in a learner map), 70 deficient links (2.3 links in average) and 7 unconnected links (0.23 links in average) by comparing individual learner map with the goal map.

By overlaying the 30 learner maps, a group map was generated. In comparison of the group map and the goal map, CmapAnalyzer detected 61 differences, that is, 26 excess links (overlay degree is more than 0), 31 deficient links (overlay degree is less than 1) and 4 unconnected links (overlay degree is more than 0). We examined all of them and corresponding portions in the learning material, and then judged that 4 differences should be accepted as alternative interpretations of the learning material. The goal map then modified to accept those four excess links. The corresponding portions of the learning materials became the targets of modification of the learning material.

Since 61 differences were too much to check in short time, we tried to filter them by using the overlay degree of each difference that is a ratio of learner maps including the difference. When we set the overlay degree to detect the differences in the group map at 0.1 in the excess link (that is, 10% of learner maps included the excess link), 0.7 in the deficient link and 0.1 in the unconnected link respectively, 8 excess links, 2 deficient links and 1 unconnected link were detected. Then all links that caused the adjustment included were detected. Therefore, the filtering with the overlay degree might be a useful method to reduce the load to the adjustment.

In the phase of learner map modification, each learner map was compared with the (adjusted) goal map and detected differences were informed each subject. The subjects were promoted to improve their map for twenty minutes. For both the unconnected link and the excess link, sentences in the learning material corresponding to the links were informed the subjects. The deficient links were not indicated because the links were pointed out as the unconnected or excess links. Therefore, in the modification phase, the correct answers were not taught directly. In this experiment, 19 in 26 subjects corrected their learner maps completely and 6 subjects left one incorrect link. One subject gave up correcting his map soon and left 5 incorrect links.

Table 1 showed the results of the questionnaires. About 90% of the subjects agreed that building the concept map (with kits) was useful to understand the learning material and kits were helpful for them to build the concept maps. About 70% of the subjects then thought the provided kits were enough to describe their understandings. The results of questions (4) and

(5) suggested that the task to build concept map was not easy for the subjects. About 90% of the subjects answered that the feedback for the concept map was appropriate, and almost all subjects thought that the activity to improve the concept map was useful to understand the learning material.

In summary, in this experimental use, a subject built a concept map composed of 49 kits and that included only 2.1 excess links, 2.3 deficient links and 0.32 unconnected links in average. The subject then corrects most of the errors with the feedback. Besides, most of the subjects thought that building the concept maps with the system was useful for learning. Because the goal map was also adjusted based on the group map, it was confirmed through the contribution of the feedback to the authors. Based on these results, we judged that interaction between learners and authors through the concept map was realized in this experiment.

3. Conclusion

In this paper, Kit-Build method and CmapSystem as an implementation of the method are described. Through three experimental uses of CmapSystem, we have cofirmed that Kit-Build method and CmapSystem are a promising approach to promote interaction between learners and teachers with concept map. The method has the following two characteristics, (A) concept map building task is divided into segmentation task and construction task, and then the segmentation task can be replaced by recognition task of the kits provide beforehand, and (B) a correct concept map that a learner should build can be specified as a goal map. These characteristics restrict the applicable targets of the Kit-Build method and require additional functions for the learning environment. Therefore, to propose and implement several measures against these restrictions are our important future works. We are also planning a large-sized, long-term and more practical use of the environment as the next step of this research.

Acknowledgement

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