

Development of a Learning Support System for Visualization and Acquisition of Knowledge through Collaborative Problem Posing

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Abstract: In this paper, we propose a learning support system that enables learners to acquire knowledge through a collaborative problem-posing procedure. One of the characteristics of this system is the view function of its knowledge map, which can be used to visualize the domain knowledge acquired by learners in subjects with a well-defined knowledge body such as mathematics, information science, nursing, and medical care. In the present study, we evaluate the effectiveness of the system through visualization of the knowledge map in a class on nursing process theory.

Keywords: LMS, CSCL, Problem Posing

1. Introduction

It is important for learners to acquire and utilize knowledge in academic disciplines requiring advanced expertise, such as mathematics, information science, nursing, and medical care. The semantic structure of these academic disciplines can be constructed under a body of domain knowledge that includes properties with hierarchies and relations. In the present study, we hypothesize that in collaborative learning, visualization of a semantic structure using a “knowledge map” is effective in knowledge acquisition and utilization, and cognition of new knowledge. We propose a computer-supported learning system that consists of (1) a web-based training (WBT) function with drills semantically related to knowledge, (2) a view function of the knowledge map that highlights the knowledge acquired by each learner in color on the basis of his/her learning results, and (3) a collaborative problem-posing function through which each learner can pose a new drill and register it into the system. To achieve (3), we modified our system to make it a computer-supported collaborative learning system. The system was introduced into a class on nursing process theory. We then evaluated the effectiveness of the system.

2. Proposed System

2.1 WBT Function

We applied “CIST-Solomon” as the system for the WBT function. CIST-Solomon is a learning management system that can manage learners’ learning processes and results (Yamakawa et al., 2011). The system includes 40,000 drill contents covering several academic disciplines such as mathematics, information science, and nursing. In the present study, a knowledge frame was also implemented in CIST-Solomon’s a relational database. It included information on corresponding drill contents and related information on the neighboring frame. The degree of learners’ knowledge acquisition was defined as the rate whether of the number of times drill contents were successfully positioned in the appropriate knowledge map or not.

2.2 View Function of the Knowledge Map

A view function of the knowledge map was implemented in CIST-Solomon. Using this function, each learner could select a knowledge frame graphically visualized on the web-based map and study learning contents related to the knowledge frame. In addition, each learner could check the status of knowledge acquisition through the map. Fig. 1 shows a screenshot of the knowledge map and drill contents.

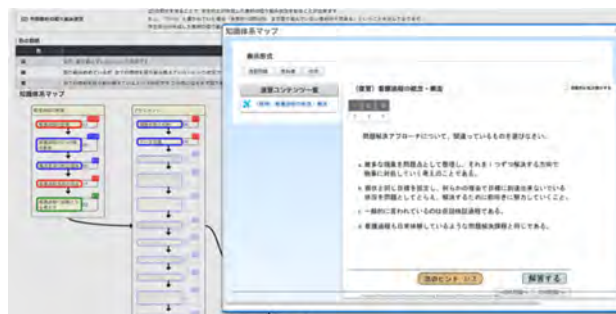


Figure 1. Screenshot of knowledge map and drill contents.

2.3 Collaborative Problem-posing Function

We implemented a problem-posing function through which learners could create and share drills in CIST-Solomon. In the problem-posing process, learners could relate the knowledge frame to the drills they created. This procedure could also be realized through the user interface of the knowledge map. The problem-posing function and the knowledge map were used for collaborative learning. Drill contents that learners created were published on the knowledge map and shared by other group members, who could solve drill contents through the knowledge map. This learning situation was referred to as collaborative problem-posing learning. It was assumed that the discovery of new knowledge was realized through the collaborative problem-posing process.

The drill format used for the problem-posing function included the description of a drill statement, an answer column, and a hint. The problem-posing procedure consisted of five steps: (1) creating a drill statement, (2) creating an answer column, (3) creating a hint, (4) selecting knowledge frame lists, and finally (5) confirming the created drill. A teacher checked the correctness of the drill contents.

3. The Outline of the Lecture

We introduced our methods into a lecture on nursing process theory held by the department of nursing of a certain university. This lecture is conducted for college sophomores and aims to teach them practical nursing skills. This basic nursing lecture has a large effect on all nursing-related fields. In national nursing tests, questions from different areas can have a major relationship with these fields. Therefore, acquiring the knowledge on basic skills provided in the lecture is important. The lecture is designed to stimulate students' productivity and to expand their understanding of nursing through group discussion and problem posing. The teaching staff involved in this lecture prepared a knowledge map, which was applied to the proposed system.

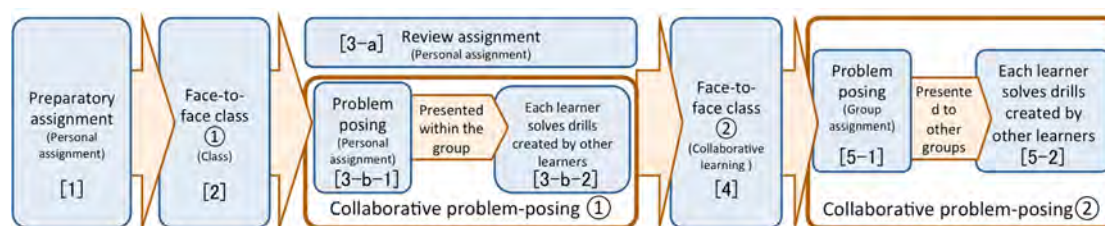


Figure 2. Class model designed.

The outline of the class is shown in Fig. 2. In step [1], using the WBT function, teachers provide preparatory assignments that include texts and drills to learners. The drill contents are related to the knowledge frame in advance. Learners can select the drills through the knowledge map. In step [2], teachers conduct a face-to-face class. In step [3-a], teachers provide assignments for the class to review. In step [3-b-1], using the problem-posing function, each learner reviews the content of the face-to-face class and poses problems for the group members to solve. Learners also select the appropriate knowledge type from the knowledge map. In step [3-b-2], each learner solves drills created by other learners using the knowledge map. In step [4], face-to-face collaborative learning is introduced. Group members are encouraged to elaborate on the knowledge they gained through the process outlined in [3-a]. In step [5-1], group members discuss their knowledge through a series of learning processes and summarize the knowledge to pose a problem for their group; each group then has to solve one problem. The created drill is shown to other group members. In [5-2], each learner can view and select drills created in the process outlined in [5-1] on the knowledge map and solve them using CIST-Solomon.

4. Evaluation

4.1 Evaluation through Questionnaire

A questionnaire survey was conducted with 69 students. In the questionnaire, students were asked to respond to the question: “What do you find useful/not useful when you use the system?” This was a free description type of question. The answers were as follows: “It’s a complicated system and hard to use,” “It’s not user-friendly, and I’m having trouble grasping what I learned.” These answers indicate that students found it difficult to operate the system. Therefore, improvements to the user interface of the view function of the knowledge map are needed.

4.2 Evaluation by Concordance Rate of Drill Contents Positioning

Students’ ability to position individual drill contents in the appropriate knowledge map showed their degree of knowledge acquisition. Students were asked to position their drill contents in the knowledge map when they pose the problem. Then, the class teacher independently positioned students’ drill contents in the knowledge map. The concordance rate of drill contents positioning could be calculated by comparing the results of both the students and teacher’s actions. The rate can be used for evaluating the view function of the knowledge map. In a previous study, students positioned their drill contents without using a knowledge map (Miura et al, 2013). At that time, the average of the concordance rate of drill contents positioning was 27%. In contrast, the average was 62% in this study. The results of a t-test showed that there was a significant difference in the results of both studies ($p < 0.05$). The results of this study indicate that the view function of our system’s knowledge map is effective for selecting appropriate knowledge types. In other words, the view function of our system’s knowledge map is effective for acquiring knowledge.

5. Conclusion

In this study, we developed a system that had a view function of knowledge map. We evaluated the effectiveness of this system after implementing it in a class on nursing process theory. The results of a questionnaire survey conducted after the class indicated that the function was difficult for students to use. However, a comparison of the concordance rates of drill contents positioning in this and a previous study showed that the view function was effective for acquiring knowledge. In the future, it will be necessary to make improvements to the view function’s user interface.

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