Visualization Supports for E-book Users from Meaningful Learning Perspective

Jingyun WANG [a*], Hiroaki OGATA [b], ChengJiu YIN [b], Atsushi SHIMADA[b]
[a]*Research Institute for Information Technology, Kyushu University, Japan*
[b]*Faculty of Arts and Science, Kyushu University, Japan*
* warmplam@gmail.com

Abstract: In this paper, we present a meaningful learning environment to visually support e-book learners to effectively construct their knowledge framework. This personalized visualization support is intended to encourage learners to actively locate new knowledge in their own knowledge framework and check the logical consistency of their ideas for clearing up misunderstandings. On the other hand, we also propose to visually support e-book instructors to decide the group distribution for collaborative learning activities based on knowledge structure of learners. To facilitate those visualization supports, we present a method to semi-automatically construct a course-centered ontology to describe the required information in a map structure.

Keywords: Visualization support, personalized learning, course-centered ontology, knowledge framework, collaborative learning

1. Introduction

Nowadays, e-book systems are widely used in education field. For example, in Arts and Science Department of Kyushu University Faculty, BookLooper e-book system, developed by Kyocera Communication Systems, is used for supporting daily classroom teaching. Those systems provides a platform for instructors to easily upload teaching materials in PDF files; on the other hand, learners can conveniently browse those files, even make markers or put comments on them. Some E-book systems, such as BookLooper, can record learners' learning activities (including which pages they read and how they switch between pages) and report to instructors (Yin et al., 2015). However, those existing systems do not provide a function to support learners to construct their knowledge framework effectively. Furthermore, it is also difficult to identify the relevant knowledge a learner possesses before and after a learning activity.

Evidence from diverse sources of researches suggests that knowledge gets incorporated into human brain more effectively when it is organized in hierarchical frameworks. "Hierarchical knowledge framework" is an organizational structure where every knowledge in this organization, except one, is subordinate to a single other knowledge; in other words, the arrangement of knowledge should be in order of rank. Learning approaches that facilitate this kind of organization significantly increase the learning capability of learners (Bransford et al., 1999; Tsien, 2007). Ausubel's learning psychology theories (Ausubel, 1963; 1968; Ausubel et al., 1978) define this effective assimilation of new knowledge into existing knowledge framework as the achievement of "meaningful learning". Therefore, how to help learners to efficiently develop their conceptual framework becomes the main issue for fostering meaning learning in e-learning field.

In response, a visualization support system for Booklooper users is designed and under development. This system is intended to not only effectively support the construction of leaners' knowledge framework, but also help instructors to decide group distribution for collaborative learning activities based on learners' knowledge structures.

2. Visualization supports for both learners and instructors

2.1 A Visualization support for learners of e-book users

For the learners in an e-book system, normally in one activity, they read several pages of a file. As shown in Fig.1, after one preview activity (for example, studying Page 10-13, which cover 7 new knowledge points) in Booklooper, the learner can login in our support system to check the new knowledge points just studied. In this research, a knowledge point (KP) is defined as "a minimum unit which can independently describe the information of one knowledge "; a KP can be acquired by practice or can be understood by its own expression. Our system will try to encourage the learner to understand the relations between the new KPs visually. Furthermore, the system also will make use of the quiz results of learners to identify the learner's acquired KPs and then encourage the learner to compare the new KPs with related acquired ones visually. Finally, the system is also expected to recommend one KP or some KPs based on individual knowledge structure and guide learners to receive personalized learning processing. With this kind of visualization support, learners using Booklooper are expected to build up their knowledge framework more effectively.

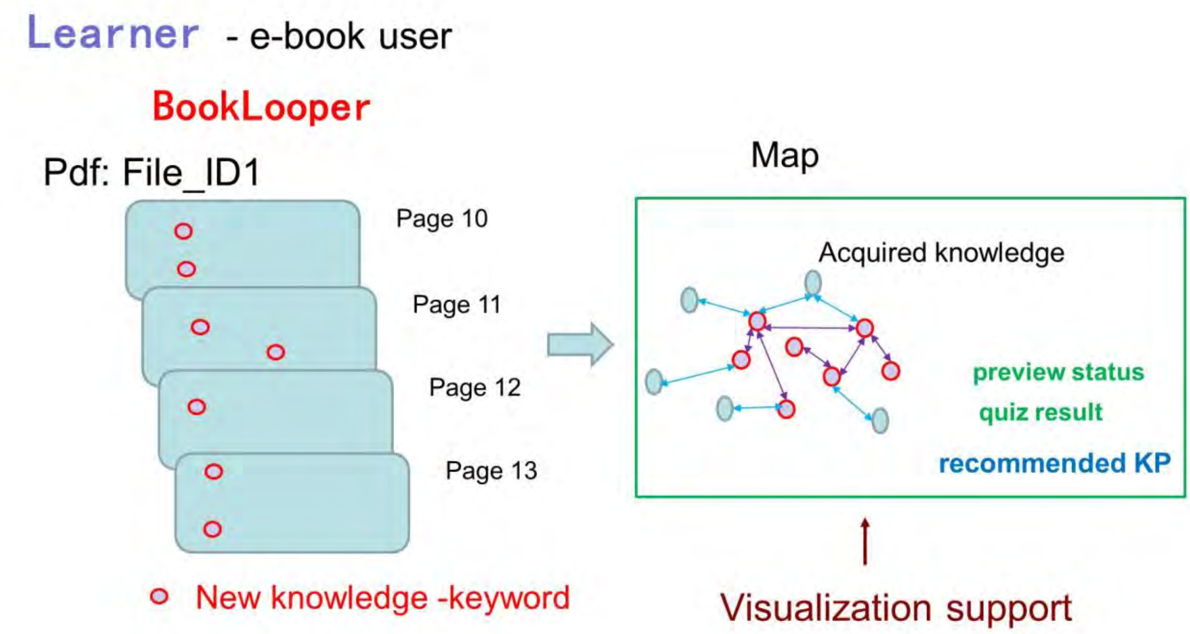

Figure 1. Visualization support for learners of e-book users.

2.2 A Visualization support for instructors of e-book users

For instructor of e-book users, we also intend to provide serval visualization supports. Firstly, the instructor can visually check all the learner's knowledge structures (including preview statuses and quiz results) thought our systems. Secondly, the system will identify the most difficult KPs or relations based on the most frequently marked keywords and will highlight them to attract instructors' attention.

Most importantly, the system will make use of the quiz results of learners to identify the learner's acquired KPs or relations and then support the instructor to decide group distribution for collaborative learning activities based on learners' knowledge structures. For example, as shown in Fig.2, assumed an instructor of a given course plans to organize collaborative learning groups to study a new KP which have 8 related KPs already taught in the course. To encourage the cooperation between learners in the same group, the system will identify Learner A, B and C, who acquired several KPs (overlap is allowed) related to the target KP respectively, and recommend the instructor to put those three learners in one group. Otherwise, if learners in one group simple know the same related KPs, it is difficult for them to realize the rest of related knowledge and reach the full understanding of the target

KP effectively during the learning processing. Based on this principle, the system will be designed to visually support instructors to decide group distribution for collaborative learning activities.

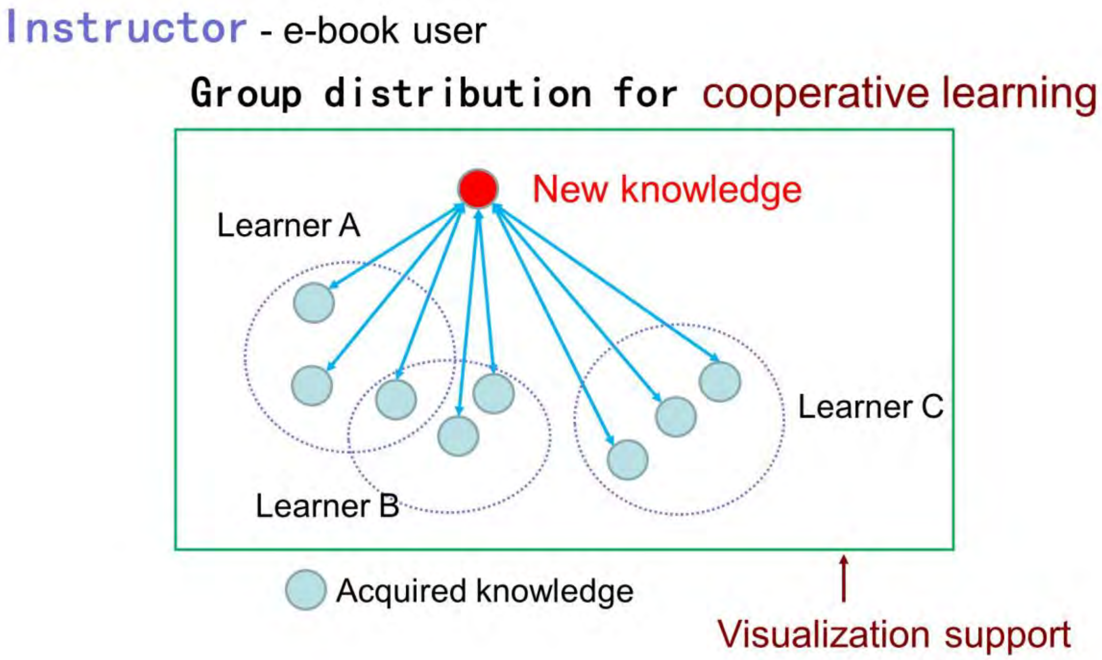

Figure 2. Visualization support for instructors of e-book users.

3. A course-centered ontology for the visualization learning support system

To facilitate visualization supports mentioned in the previous section, the description of the information about all the KPs and relations between KPs is required for the system. In this paper, we present a method to semi-automatically develop a course-centered ontology to describe all those required information from the knowledge in courses.

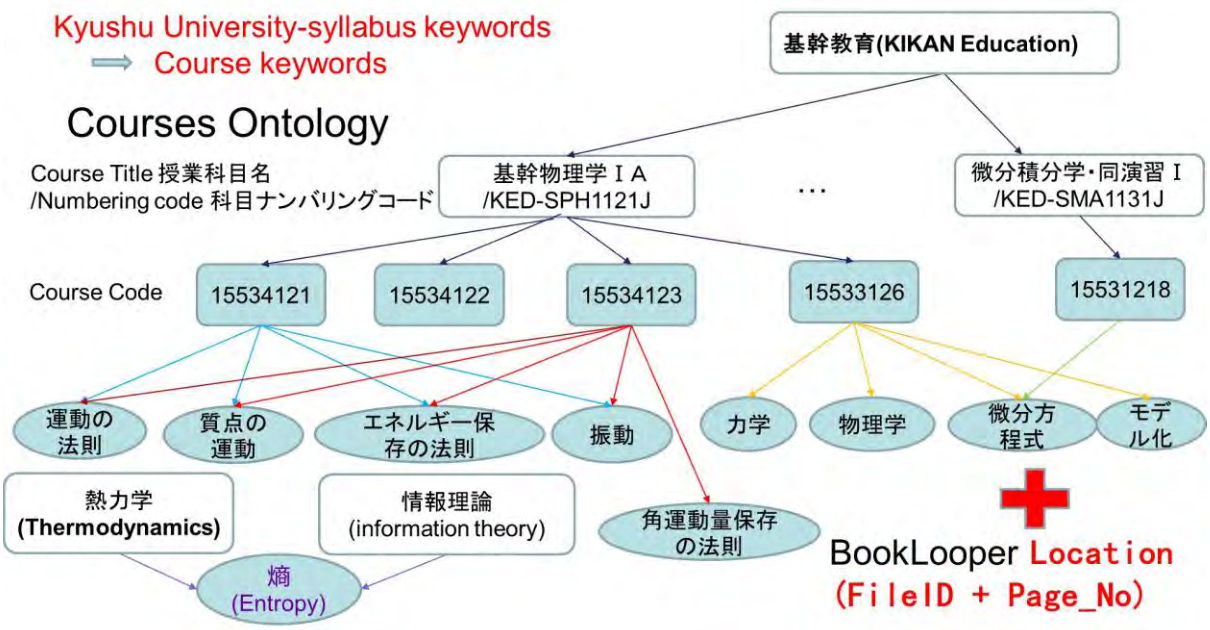

Figure 3. The basic framework of the course-centered ontology based on Syllabus information.

Firstly, we automatically exact the information from "Syllabus system" of Kyushu University and create the basic framework of the course-centered ontology. As shown in Fig. 3, for example, for the Kikan Education of in Arts and Science Department, there is 3730 courses registered in syllabus system. For one Course Title, there are several courses taught by different professors or instructors; those courses may share some same keywords or have completely different keywords. One keyword also can be shared by courses which have different Course Titles. One typical example is "Entropy", which is not only taught in *Thermodynamics* courses but also in *Information theory* courses. In this step, the information of "course title/numbering code", "course code" and "keywords" from Syllabus are automatically exacted and used for the construction of the basic framework for ontology.

However, for most of the courses in syllabus system, less than 10 keywords are described; the basic ontology framework built on those syllabus keywords is far sufficient to provide the visualization support described in the previous section. Therefore, in the second step, we encourage professors/instructors to manually modify the ontology using `protege` ontology editor (Horridge M., 2011) and then upload the modified ontology with the description of its related PDF file IDs in BookLooper.

For build up a demo, we applied and adjusted the ontology design method described by Wang et al. (Wang et al., 2014) to develop a course-centered ontology of an existing computer science course (called COCS). We analyzed the learning materials of this computer science course, extracted about 100 KPs and about 20 kinds of relations, and defined them in COCS. Fig 4 illustrates some KPs and their relations in COCS. We will describe the way, in which COCS is designed and developed, to show professors/instructors of other courses how to build up their course-centered ontology. Without doubt, how to combine all the course-centered ontology made by different professors/instructors into one ontology will be another issue we need to discuss in the future.

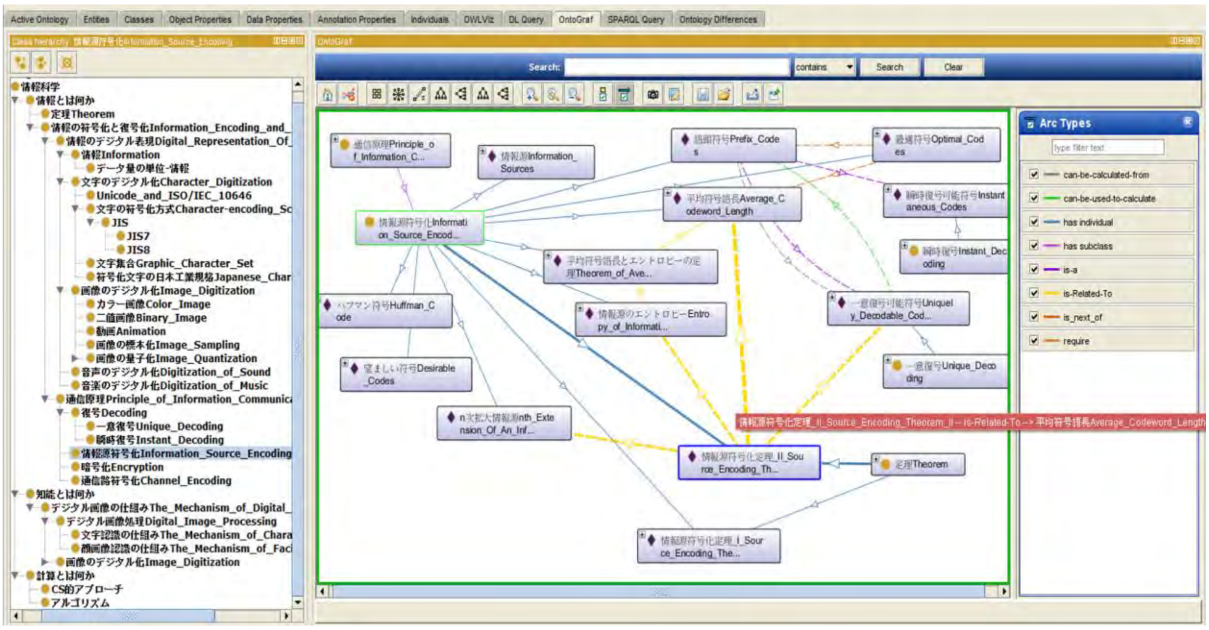

Figure 4. The Course-centered Ontology of Computer Science (COCS)

In the Last step, we will try to automatically identify the location (including the file ID and the Page Number) of the KPs in the BookLooper system and put those location information into the ontology.

Based on these three steps, the course-centered ontology will be developed semi-automatically. Then, to automatically manipulate this ontology, a system which is intended to provide visualization learning supports will be developed. We expect the system not only can provide the visualization support for the construction of learner knowledge framework but also can help instructors to understand the learners' knowledge structures and easily decide group distribution for collaborative learning activities.

4. Combination with the information from "Academic Staff Educational and Research Activities Database"

Beside the information of KPs and their relations in courses, we also plan to input the research information into the course-centered ontology by making use of the information from "Academic Staff Educational and Research Activities Database" of Kyushu University.

"Academic Staff Educational and Research Activities Database"(ASERAD) is a system disclosing educational and research activities of professors/researchers in Kyushu University. All the information in this database derives from the data submitted by professors/researchers. Each professor/researcher's field of specialization can be browsed from ASERAD. However, it is difficult to understand the exactly meaning of those words written in "Field of Specialization". Therefore, we propose to provide a visualization support (as shown in Fig. 5) to enable the users of ASERAD to check the words in "Field of Specialization" from the university courses point of view.

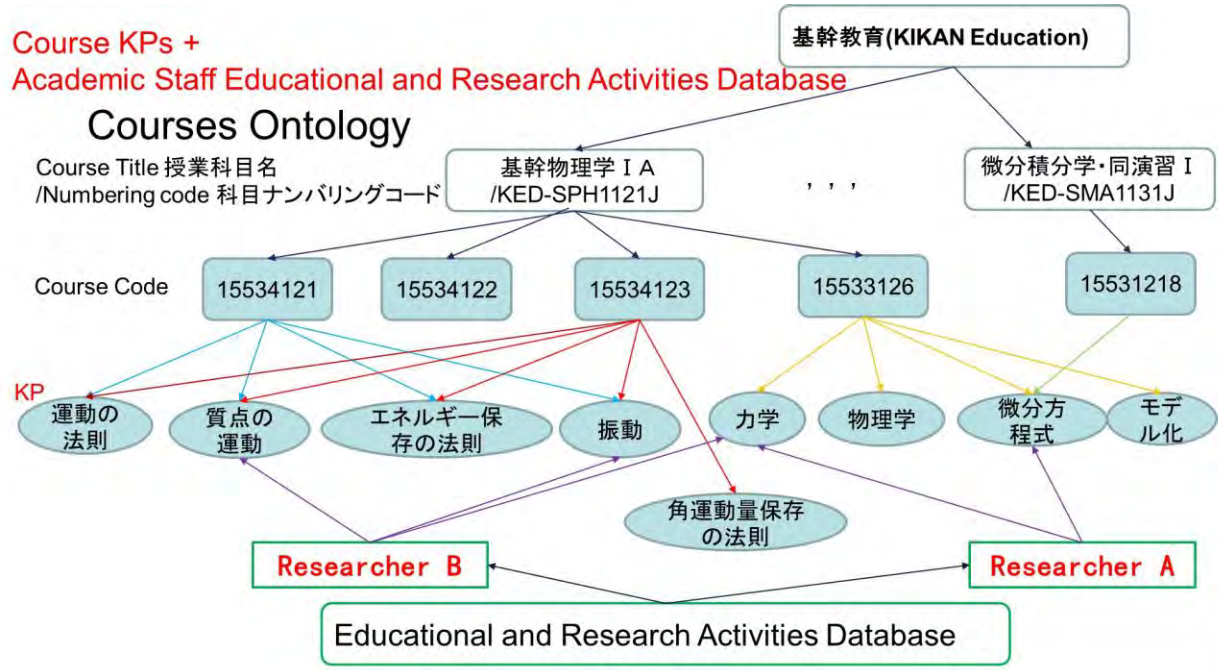

Figure 5. Visualization support for instructors of e-book users.

The information of "Organization", "Position", "Name", and "Field of Specialization" from syllabus will be automatically exacted. And then the system will calculate the similarity's and make matches between "Field of Specialization" and the name of KPs in the course-centered ontology described in the previous section. We expect "Field of Specialization" of professors/researchers will be understood more easily based on this support.

5. Conclusion

In summary, we present a semi-automatically method to construct a Course-centered Ontology. Based on this Course-centered Ontology, we intend to design a system to provide visualization support for BookLooper e-book users. For learners of BookLooper users, the system is designed from the perspective of meaningful learning to visually support them to effectively construct their knowledge framework. For instructors of BookLooper users, when they are planning collaborative learning activities, the system can provide visualization support to help them to decide the group distribution based on knowledge structure of learners.

Acknowledgements

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