Toward an Ontology-aware Support for Learning-Oriented Knowledge Management

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Abstract

It is important for running an organization to support learning for knowledge acquisition and creation and to encourage spread and inheritance of new knowledge on the proper understanding of relations between individuals and organizations. This paper presents ontology-based framework of information systems for knowledge management focused on a learning system in organization. Major characteristics of this framework are derived from "Ontology" which is used as an index of knowledge and "Dual loop model" which represents the flow of knowledge in an organization. Since these two things enable the framework to grasp the meaning of knowledge and the progress of organizational learning, it can provides appropriate support for knowledge management Then we will introduce two systems as concrete examples, namely a knowledge management support environment: *Kfarm* and a learning contents design environment: *i*Designer.

Keywords: Learning Contents, Learning Organization, Knowledge Management, and Ontology

1. Introduction

Recently, knowledge sharing, inheritance and creation in an organization have drawn attention under the slogan 'knowledge management'. In this study, we aim to develop an information system for knowledge management that takes 'learning' as its principal axis. Based on the proper understanding of the relations between individual learning and organizational learning, it supports knowledge acquisition and creation and encourages spreading and inheriting of new knowledge. We call it 'learning oriented knowledge management'.

To realize this idea, it is necessary to clarify relation between individual learning, which includes acquisition and use of knowledge and externalization of its product, and organizational learning, which is aggregation of individual learning. We mainly focus on the two points shown below:

- Ontology: A model which describes contents of knowledge learned in an organization.
- Dual loop model: A computer-aided model which supports for individual and organizational learning activities.

Ontology and 'Dual loop model', which we propose in this paper, act as the basis of these points.

In this paper, we introduce the dual loop model and describe the role of ontology in the learning-oriented knowledge management. We also introduce two systems, namely a knowledge management environment: *Kfarm* and a learning contents design environment: *i*Designer, and coordination of them as an implementation of our idea.

2. Dual loop model

In this chapter, we will propose a model based on which computers support the knowledge-creating activities in an organization. Our goal is to present a framework that supports all the activities from the practical ones in an organization to the knowledge creation ones. In this research, inspired by the theories of Senge's 'Learning Organization' (Senge 90) and Nonaka's 'Organizational Knowledge Creation' (Nonaka 95), some activities related to the formation of organizational knowledge are explained from both viewpoints of the 'individual' as the substantial actor in an organization and the 'organization' as the aggregation of the individuals. The two viewpoints are modeled as two separated loops of activities with explicit interactions between them. The whole model called "Dual Loop Model" is illustrated in Figure 1. It works as a reference model for designing a knowledge management support system, *Kfarm*, we will see in the next chapter. The dual loop model is constructed from an individual's knowledge conversion process (Figure 1 (A), personal loop) and organizational knowledge conversion process (Figure 1 (B), Organizational loop), and it represents the flow of knowledge between them.

In Figure 1, (1)-(7) represent the events of individual's activities and (8), (11) and (12) represent the events that trigger off individual's activities performed in the personal loop. These are defined in connection with con-

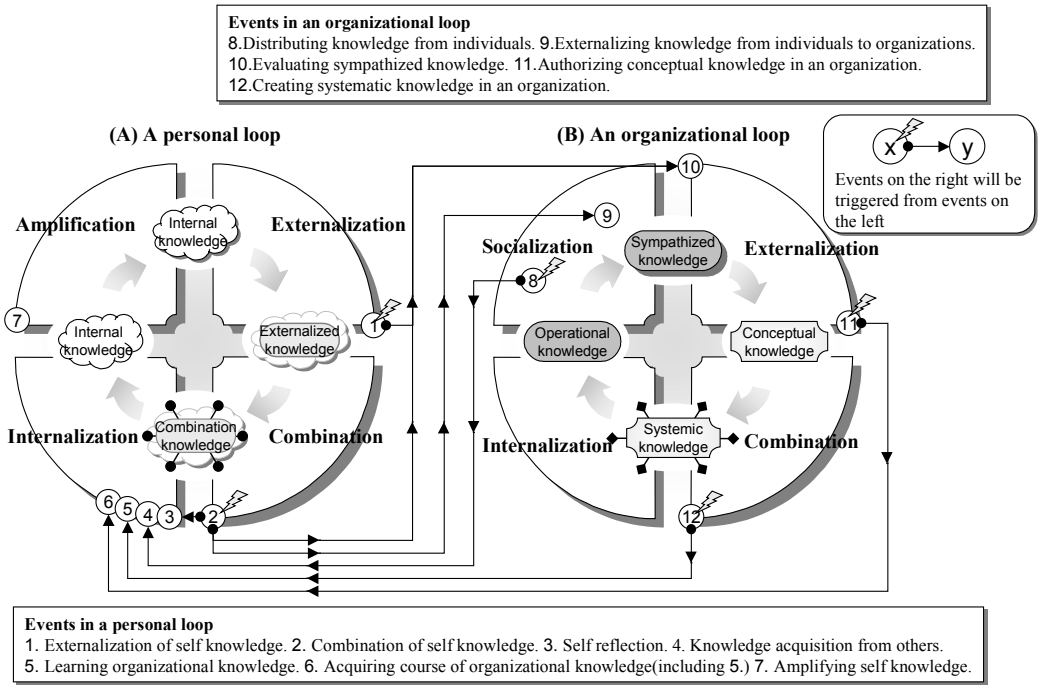

Figure 1: Dual loop model (partly simplified)

ditions of user's activity in the personal loop and events in the organizational loop. For example, (8) represents such an event as 'knowledge distributed by individuals', (4) represents 'obtaining knowledge from others'. The arrow from (8) to (4) shows a causal link between the two events.

3. Knowledge management support system based on ontology

3.1 A role of ontology

Kfarm is an ontology-based knowledge management support system. We have been developing *Kfarm* centered on documents and folder handling, in which users can participate in organizational learning in an easy way that has no major differences to that in an ordinary computer environment.

'Knowledge' handled in *Kfarm* is expressed in documents. Ontology (Mizoguchi 98) is the basis for clarifying contents of the documents. We define the concept for describing knowledge in documents as an organizational ontology. An ontology in *Kfarm* works as meta-information about contents of documents and enables *Kfarm* to support sharing and managing knowledge in an organization.

Since directly referencing the conceptual definition of ontology would cause unnecessary work for users, *Kfarm* provides simple indexing scheme, that is 'term index', to K-practitioners. The term index represents contents of documents and folders by terms (shown in Figure2(C) and (D)) related to the conceptual definition of ontology. In *Kfarm* only K-engineers are privileged to manage ontology and provided with editing tools such as Ontology Editor (Kozaki 00).

3.2 Structure of *Kfarm*

We designed the system structure referencing the organization structure of "middle up-down management (Nonaka 1995)." Nonaka and Takeuchi suggested the organization structure as an example of an organizational model that promotes a knowledge creation process. In this model, top (executives), middle (middle manager), and lower (employees) from organizational viewpoint layers are called knowledge officers (K-officers), knowledge engineers (K-engineers), and knowledge practitioners (K-practitioners) from a knowledge creating viewpoint layers, respectively. The K-engineers are expected to coordinate between K-officers' visions and the K-practitioners' practical activities and to promote innovative knowledge creation within a particular order of the organization. In the following, relating K-practitioners and K-engineers with the dual loop model, we will explain support functions of *Kfarm*. Fig. 2 shows the interfaces of each environment. Although five buttons correspond to functions 5 and 6 in Fig.2 are provided only to K-engineers, K-practitioners will be provided similar interfaces except for those five.

3.2.1 K-practitioner environment

K-practitioners participate in organizational learning through either their own documents or documents obtained from outside. K-practitioners' basic tasks and their support functions are as follows:

Sorting: select a term from the terminology trees (Figure. 2 (c)) and put the term on a folder as an index. By putting documents into the indexed folder, the documents have the same indexes as the folder and are converted to conceptual indexes in *Kfarm* (e.g. function 1).

Support: providing terms based on ontology and making clear term descriptions.

Distribution: distribute one's documents with term indexes to interested people (e.g. function 3-2).

Support: knowledge awareness support.

Reference: search and reference documents of others and organizations, bulletins and learning contents based on terms and one's situation (e.g. function 2,3).

Support: visualizing know-who/know-what information.

3.2.2 K-engineers environment

K-engineers lead organizational learning, based on the organization's visions, by adopting created knowledge and concepts in an organization. Therefore, all behavior/events in a K-practitioner environment will be informed to K-engineers. This information will give K-engineers more opportunities to collect new concepts of K-practitioners. K-engineers' basic tasks are as follows:

Understanding circumstances: understand K-practitioners' folder making event and document exchange event (e.g. function 6).

Support: informing distribution events and visualizing knowledge exchange.

Editing: make bulletins in order to make clear the direction of an organization (e.g. function 5-1).

Support: functions for making bulletins.

Authorization: authorize the useful documents from K-practitioners' documents in organizational activities (e.g. function 5-2).

Support: informing distributing events and visualizing knowledge exchange.

Sorting: put conceptual indexes as official meanings in an organization on documents (e.g. function 5-2).

Support: organizational shared folders and ontology editing functions.

Distributions: distribute documents among K-practitioners according to the situation of an organization (e.g. function 3-2).

Support: visualizing know-who information.

Searching learning contents: search learning contents and target people that match the situations of an organization and distribute them (e.g. function3).

Support: visualizing organization conditions and searching based on ontology.

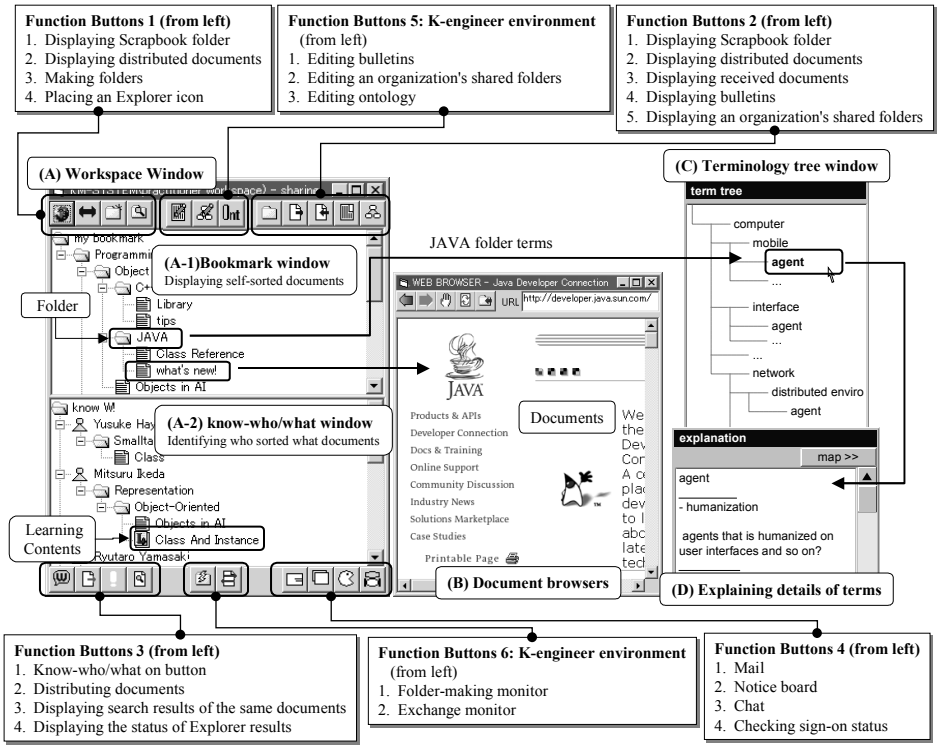

Figure2: User interfaces in Kfarm (K-practitioner environment)

4. Learning contents for a learning organization

In order to support inheritance and creation of an organizational knowledge in the dynamic knowledge creation process, it is necessary to systematize learning contents by taking the whole knowledge conversion process in an organization into consideration.

Learning contents can be seen as documents including both *explicit knowledge* and *tacit knowledge* that members use to carry out activities required in an organization. In general, documents have structures based on the purpose of their use, and the structure of the learning contents can be considered to express 'guaranteeing rationality of proper procedures for acquiring knowledge'. By placing learning contents under the management of *Kfarm*, we aim to support inheritance of organizational knowledge, which is the basis of knowledge creation and organizational activities, to ensure proper progress.

The following points are important to realize the support:

- Management of learning contents connected with organizational knowledge management.
- Guaranteeing quality of learning content.

Based on the above two points, ontology-aware authoring tool *i*Designer, which has been developed in our previous research, plays a role as an external application for learning contents design. *i*Designer provides users with support for designing rational learning contents based on an ontology about learning contents. The establishment of ontological connection between the organizational knowledge in *Kfarm* and the learning topic network of *i*Designer lays the basis for

- clarifying up-to-date needs for learning in organization,
- guaranteeing pedagogical rationality of learning contents to meet the needs,
- encouraging learner's self-motivated learning in knowledge creation, and
- supporting learning contents distribution based on organizational vision/strategy.

5. Concluding remarks

Organizational learning can be taken as an aggregation of individual learning, and it is necessary that an individual's knowledge increase for an organization to increase its knowledge. To realize this, it is also necessary to increase an individual's knowledge that matches the value of the idea from organizational viewpoint. By meeting those two requirements, it is thought that beneficial knowledge for an organization will be created and the identity of the organization will be established.

In this paper, where an individual's learning becomes the basis of organizational learning, we have suggested *Kfarm* as an architecture for IT systems, which supports giving direction based on organizational visions by K-engineers and the cooperating of knowledge creation by K-practitioners. *Kfarm* can monitor learning processes in an organization and can provide adequate support based on the correspondence between user operations and events on the dual loop model.

*i*Designer we have already developed can be generalized as a general-purpose design support environment for learning contents. Its deeper cooperation with *Kfarm* can be a future subject. For example, it will be possible to better fulfill learning support in an organization's activities by connecting user models in *Kfarm* with learner models obtained with the use of learning contents. Furthermore, we are considering incorporating it from a point of human resource management, in the framework of learning support in an organization.

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