Knowledge Management Framework for Collaborative Learning Support

Mizue KAYAMA* & Toshio OKAMOTO**

*Senshu University,
School of Network and Information
Higashimita 2-1-1, Tama, Kawasaki, Kanagawa 214-0002, JAPAN
kayama@isc.senshu-u.ac.jp

**University of Electro- Communications
Graduate School of Information Systems
Chofugaoka 1-5-1, Chofu, Tokyo 182-8585, JAPAN
okamoto@ai.is.uec.ac.jp

Abstract

The purpose of this study is to support the learning activity in the Internet learning space. In this paper, we examine the knowledge management and the knowledge representation of the learning information for the collaborative learning support. RAPSODY-EX (REX) is a distributed learning support environment organized as a learning infrastructure. REX can effectively carry out the collaborative learning support in asynchronous/synchronous learning mode. Distributed learning is a learning style where individual learning and collaborative learning are carried out on the multimedia communication network. In the distributed learning environment, arrangement and integration of the learning information are attempted to support the decision making of learners and mediators. Various information in the educational context is referred and reused as knowledge which oneself and others can practically utilize. We aim at the construction of an increasingly growing digital portfolio database. In addition, the architecture of the learning environment that includes such a database is researched.

Introduction

The development of the recent information communication technology is remarkable. As an effect of this, the education environment is being modified to a new environment which differs qualitatively from the previous one (Kuhn 1962). The new education environment contains not only computer but also communication infrastructures such as the information communication network represented by the Internet (Cumming et. al 1998) (Elliot 1993). We call this learning environment the Internet learning space. Information is transmitted for the learner in this learning space from the external space. The information quantity that is available to the learner is enormous. However, there is a limit to the information quantity, which the learner can process. The imbalance of this information processing quantity is a peculiar phenomenon in postmodern ages. Secondary phenomena are also triggered by this problem. These phenomena become factors which inhibit the sound transmission of knowledge and the progress of learning (McNeil et al. 1998) (Chen et al. 1997). In asynchronous learning, the transformer of knowledge and the transformee of knowledge communicate with a time lag. In such a situation, more positive support is required to realize an effective and efficient learning activity. We need to build a learning infrastructure with learning spaces with various functions.

The Purpose of This Study

We investigate the mechanism of transmission and management of knowledge for the development of the knowledge community in the learning space, within the educational context. In this paper, we examine the knowledge management and the knowledge representation of the learning information for the collaborative learning support. The purpose of this study is to support the learning activity in the Internet learning space. REX is a distributed learning support environment organized as a learning infrastructure (Okamoto et. al 2000). REX can effectively carry out collaborative learning support in asynchronous/ synchronous learning mode. Distributed learning means using a wide range of information technologies to provide learning opportunities beyond the bounds of the traditional classroom. Some examples of distributed learning technologies include the World Wide Web, email, video conferencing, groupware, simulations and instructional software. A distributed learning environment facilitates a learner-centered educational paradigm and promotes active learning. Distributed learning is a learning style where individual learning and collaborative learning are carried out on the multimedia communication network. In this environment, arrangement and integration of the learning information are attempted to support the decision making of learners and mediators. Various information in the educational context is referred and reused as knowledge which oneself and others can practically utilize. We aim at the construction of an growing digital portfolio based on the agent technology. In addition, the architecture of the learning environment including such a database is researched.

Distributed Education/Learning System

Distributed education/learning support systems are classified into 2 types. One type is systems using the advanced information network infrastructure to realize smooth communication for distributed education/learning. The other type represents systems, which positively support various activities of distributed education/learning.

As examples of the former, we can indicate the Open University, which provides a correspondence course in the United Kingdom (Kaye 1994) and the other online universities (UoP) (JIU). In addition, ANDES which is a satellite communication distance education system using digital movies (Shimizu 1999) and the synchronous distributed education system which apply Web browser sharing technology(Kobayashi et al. 1998) should also be mentioned.

As examples of the latter type, the "TeleTOP" at the University of Twente(Collis 1999), and a distributed education system which does not utilize the WWW technology at the University of Trento(Colazzo, and Molinari 1996) are pointed out. The "Electronic Learning" project at the University of Southern California (Johnson and Shaw 1997) provides an intelligent tool which supports designing of the learning course and authoring of the teaching material for distributed education. A distributed education system with synchronous and asynchronous learning mode at IBMJapan (Aoki and Nakajima 1999), applies the Web operation recording technology .

For both types of systems, some agent-based distributed learning environments are also reported (IPAJ 1999) (JIFETS 2000) (JILR 1999). Some of them are implemented with some standardizing technologies (CORBA including FIPA (FIPA), OMG(OMG) and Agent Society (Agent Society)). Agent technologies are useful to realize multi-users learning environment. We have explored an intelligent media oriented distributed e-Learning environment. In this system, we developed a learning management system and some learning control mechanisms based on agent technologies. Some collaborative learning media controlled by agents are also developed.

Collaborative Learning with REX

A learner group that guaranties the smooth transmission of knowledge can form a community (the knowledge community) by sharing and reusing common knowledge. The image of collaborative/ group learning with REX is shown in figure 1. Learning activities that occur within this group are as follows:

- achievement of learning objectives as a group;
- achievement of the learning objectives of each learner;
- achievement of the learning objectives of the learner group which consists of multiple learners.

REX supports the transmission of knowledge in the learner group and the promotion of the learning activity. It is indispensable that REX has the following functions:

1) function which controls learning information for the individual learner and the group.
2) function which manages learning information of the learner for mediation.

The learner and group information are produced from the learning space. This information will be stored in the collaborative memory (CM). This information is defined as learning information. We also define the method of information management of such information and the structure of the CM.

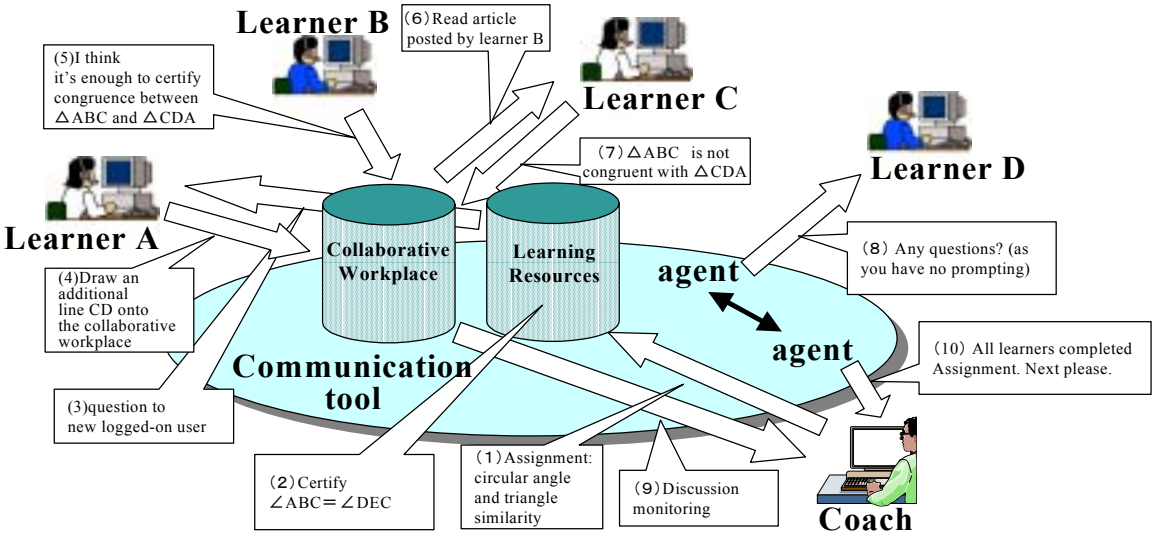

Figure 1 Collaborative learning with REX

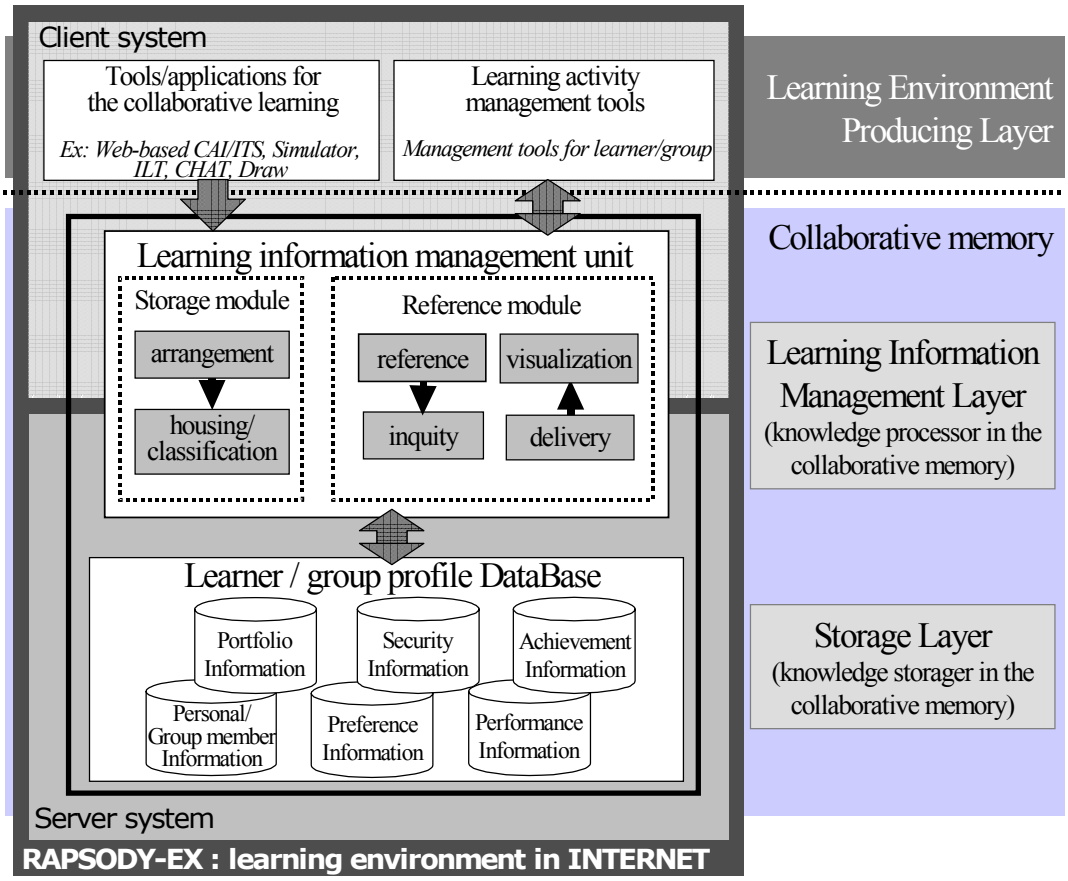

Figure 2 The mechanism schema of the REX

The Management of Learning Information

The simple mechanism of the management of learning information developed in this study is shown in figure 2. The processing mechanism consists of two components. The first one is a module that offers the learning environment. The second one is the CM that controls various information and data produced from the learning environment. In the learning environment, 2 types of functions are offered. One is the monitoring function for the learning progress. The other is the tool/application for the collaborative learning. The former function controls the learning history/record of individual learners and the progress of the collaborative group learning. The latter tool/application becomes a space/workplace for collaborative synchronous /asynchronous learning. The learning information, which emerged from such a learning environment, is handed to the CM. The CM offers 2 types of functions. One is the knowledge processing function, and the other is the knowledge storage function. In the former, input learning information is shaped to the defined form. In the latter, for the formatted information, some attributes related to content are added. The complex information processing takes place in the CM.

The Knowledge Management in REX

In this study, the processing described in the previous section is considered as a process of the knowledge management in the learning context. Knowledge management is defined like follows (Davenport 1997). The knowledge management is "*the systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest*."

Nonaka arranged the process of knowledge management as a SECI model (Nonaka 1995). The SECI model is expressed as a conversion cycle between tacit knowledge and expressive knowledge. Tacit knowledge has a non-linguistic representation form. Expressive knowledge is a result of putting tacit knowledge into linguistic form. Tacit knowledge is shared with others by converting it into expressive knowledge. In the SECI model, socialization

(S) / externalization (E) / combination (C) / internalization (I) of knowledge is expressed.

The knowledge management in educational context is defined as follows: "the systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves a learner's comprehension and/or ability to fulfill his/her current learning objectives." REX aims to support participants' activities in the C (combination of knowledge) phase. Moreover, it affects not only the process of knowledge conversion from the C phase to the I (internalization of knowledge) phase, but also from the E (externalization of knowledge) phase to the C phase. The information of learning entity contains the expressed knowledge by learners. This overt knowledge can be represented by natural language as verbal information. So, we can regard this knowledge as one that would be elicited from the learner's tacit knowledge.

In this situation, what we have to consider is as follows:

- *Who are the subjects of our knowledge management work?*
  Learners and the persons who support the learners are our subjects. Learners' task is to acquire the ability/skill for the problem solving. On the other hand, supporters' tasks are to support for acquisition of ability/skill of the learner, and to support of the problem solving by the learner. Supporter means a facilitator/tutor/coach/ organizer etc.
- *What are the knowledge resources in the learning group?*
  For learners, the knowledge for the effective and efficient problem solving is their knowledge resource. On the other hand, for the supporters, the knowledge on problem setting and activity assessment is their knowledge source.
- *What is the gain for the learning group?*
  The gains for learners are to acquire the ability in which to effectively and efficiently solve the problem, and to acquire the meta-cognition ability. For supporters, the acquisition of the ability of supporting the ability acquisition of the learner is their gain.
- *How are the knowledge resources controlled to guarantee the maximum gain for the learning group?*
  By the information processing to relate common knowledge of the CM and learning context, we try to manage the knowledge in the collaborative learning. To create the collaborative portfolio between individual and group learning, extension of acquired knowledge of learners, knowledge extraction from learning history under the problem solving and making outline of problem solving process.

The Collaborative Memory

In the CM, information generation / arrangement / housing / reference / visualization are the management processes of expressive knowledge in the learning space. REX is a learning environment, which possesses a knowledge management mechanism. In this environment, 1) the review of the learning process, 2) the summarization of the problem solving process and 3) the reference of other learners' problem solving method are realized in the learning space. Learning information is expressed by an unified format. Then, that information is accumulated in the CM. This information becomes the reference object of the learner. The generation and the management of the information on the learning performance and the portfolio of the learner and group are main objects of the knowledge management. In this study, learning information is obtained from the application tools for the collaborative learning. It is necessary to control the learning record, the reference log of the others' learning information and the log of problem solving and learning progress. To realize this control not only techniques based on symbolic knowledge processing approach, but also techniques based on sub-symbolic knowledge processing approach are used.

The CM consists of two layers. One is the information storage layer and the other one is the management layer of the stored information. At the information storage layer, 4 kinds of information are mainly processes.

1) Learning information,
2) Information on the learner,
3) Information on the setting of the learning environment
4) Information on the learning result.

At the information management layer, the reference/arrangement/integration of learning information are processed. The individual learner profile information is composed of information following the IEEE Profile information guidelines (IEEE 2000). The group information is expressed by the expansion of the individual learner profile information. The conversion from the learning log data to learning information is necessary to develop this profile database. The information, which should apply in learning information, is as follows:

- information and/or data on its learning context and/or learning situation
- information about the sender and the sendee of the information
- significance and/or outline in the educational context
- information on the relation structure of the learning information
- reference pointer to individual learner and group who proposed or produced the information
- relation with other material

By adding these information, the learning information is arranged into an unique form. If a learner requires some information related to his/her current learning, REX shows the (estimated) desired information to the learner.

Figure 3 shows a communication scheme in the REX. Three types of agents are existed in the REX. These agents perform each mission with user (user-RAPgent),

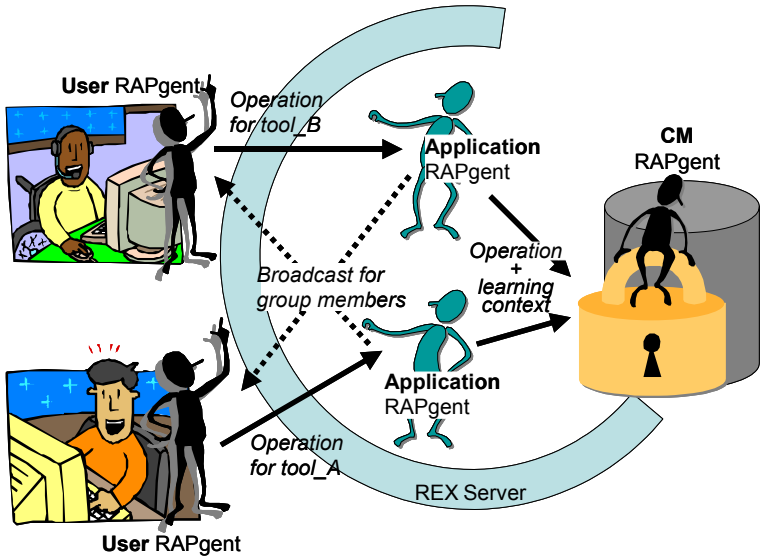

Figure 3 Communication scheme in the REX

collaborative learning tool (application-RAPgent) and the CM in REX server (CM-RAPgent). Communication protocol between RAPgents is defined based on the FIPA ACL communicative act. The missions of each RAPgent are to transform information adaptively to create group portfolio, to maintain learning contexts in the group member and to let refer information in CM. To realize the knowledge management in REX, application-RAPgents develop some learning contexts by using learning information in the CM. Then they refer the suitable learning information for the collaborative tool/application.

Examples of the Knowledge Management in REX

Figure 4 shows the window images of the collaborative applications on REX. Two types of applications are loaded. One is a chat tool for the text communication among the group member. Another application is a collaborative simulator for the . Each application has each application-RAPgent. By the functions of these RAPgents, learning history data at this session is stored in the CM and formulates a set of the group portfolio.

The examples of knowledge management at this session are shown in the figure 5. A log data of this dialog is visualized by three kinds of methods. These results are produced by three application RAPgents.

The first method is visualization of the dialog structure. The dialog layers are reasoned based on the dialog proceeding model (Inaba 1997) and the utterance intention information that were given to the dialog log. The result is shown as tree structure. The second method is visualization of transition of the contents of a dialog. An appearance of the important term that is in a dialog is searched for using the term dictionary about the current discussion/learning domain (Chiku 2001). This result and the timing connection of each utterance are considered to detect a transition of the contents of a dialog. The result is shown as graph structure.

The third method is visualization of transition of problem solution process. One utterance can be unified as meaningless unit for the problem solving process from the first and the second processing result and an educational mentor's expertise/educational intentions. The result re-constituted as problem solution process is shown with the structure that imitated the dendrogram

Conclusion

The purpose of this study is to support the learning activity in the Internet learning space. We examine the knowledge management and the knowledge representation of the learning information for the collaborative learning support. REX is a distributed learning support environment organized as a learning infrastructure.

In this paper, the management of learning information in REX is described. REX is an integrated distributed learning environment and supporting tools/ applications for the collaborative learning. Also, in this paper, the knowledge management mechanism in the educational context is showed. The detailed knowledge management technique is exploring by using the semantic web approach, and it will be integrated with the current learning support environment.

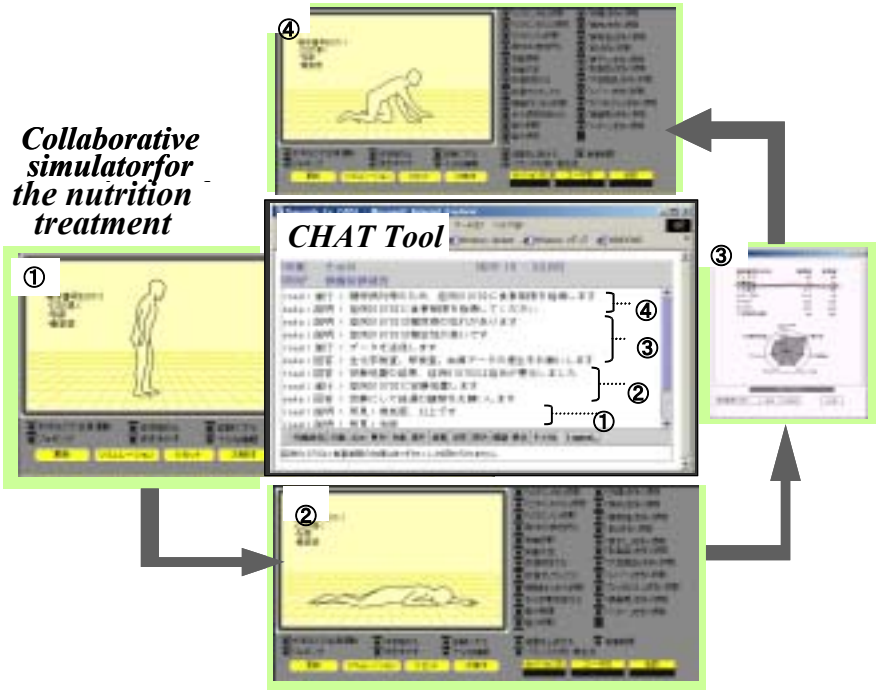

Figure 4 Two types of collaborative learning applications
<a chat tool and a collaborative simulator for the nutrition treatment>

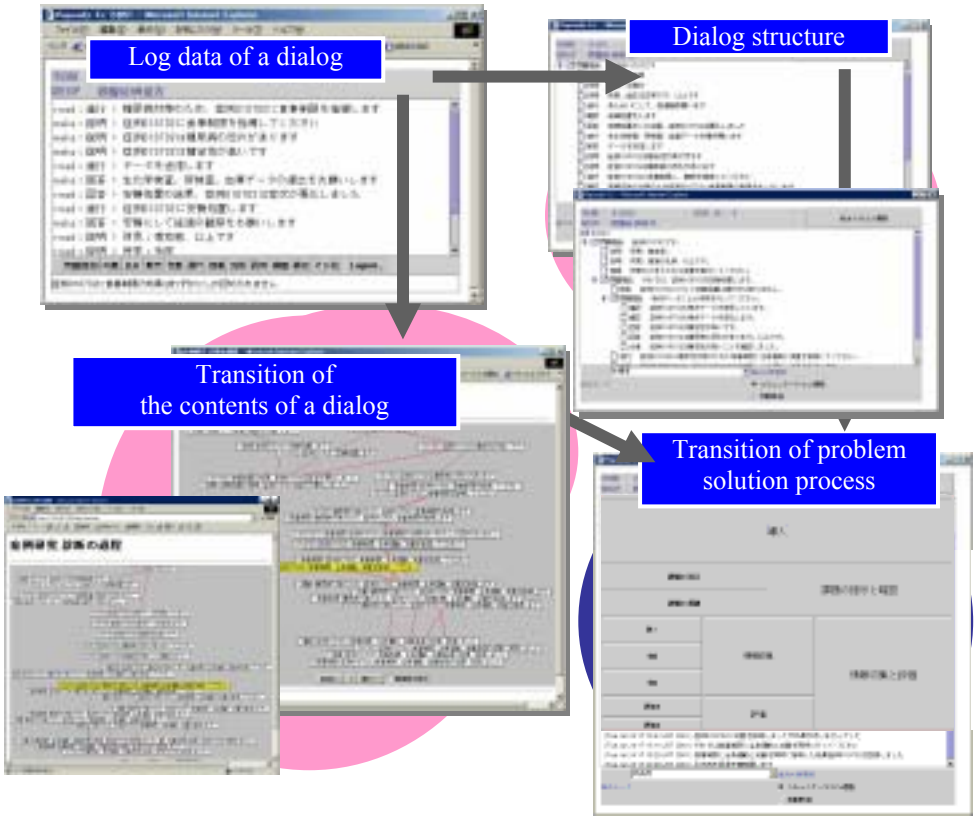

Figure 5 Examples of Knowledge Management in REX

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