

Knowledge Awareness Map in a Web-Based CSCL Environment

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Abstract: This paper describes an open-ended and collaborative learning environment in WWW. In the environment called *SharlokII*, the learners provide and share individual knowledge and other knowledge on the WWW and discuss about them. This paper focuses on *knowledge awareness map* and its design, implementation and evaluation. The map visualizes the relationship between the shared knowledge and the current and past interactions of learners. The map plays a very important role of finding peer helpers, and inducing collaboration.

Introduction

Recently, researchers in the educational systems area are attempting to provide technological support for cooperative and collaborative learning advocated by educational theories (Slavin, 1990; Webb & Palincsar, 1996; O'Malley, 1994). This paper focuses on an *open ended and collaborative learning environment*. For this situation, CoVis (Edelson et al., 1996), KIE (Linn, 1996), CSILE (Scardamalia & Bereiter, 1996), WebCamile (Guzdial et al., 1997) and Belvedere (Suthers & Jones, 1997) have been developed. CoVis focuses on making a collaboration process visible. KIE succeeds by helping students link, connect, distinguish, compare, and analyze their repertoire of ideas. CSILE and WebCamile support knowledge building for the creation of knowledge. Moreover Belvedere that is a networked software system, was implemented to provide learners with shared workspaces for coordinating and recording their collaboration in scientific inquiry. In such environments, distributed expertise and multiple perspectives enable learners to accomplish tasks and develop understandings beyond what any could achieve alone. Therefore, it is very important for learners to collaborate with each other. However, little attention has been given to the technical support for inducing collaboration in distributed leaning spaces connected via Internets.

In computer supported cooperative work (CSCW), *awareness* is one of the most interesting topics, which can increase communication opportunities in a distributed workspace. Dourish and Bellotti (1992) defined *awareness* as "*understanding of the activities of others, which provides a context for your own activity.*" In CSCL (computer supported collaborative learning), *Knowledge Awareness (KA)* have been proposed to bridge learners who are interested in the same knowledge and to create effective collaboration in a distance learning environment (Ogata et al., 1996a; Ogata & Yano, 1997). KA gives learner information about other learners' activities in a shared knowledge space. Its messages are, for instance, "someone is looking at the same knowledge that you are looking at", "someone changed the knowledge which you have inputted." These messages of KA encourage collaboration by exciting learner's curiosity and by active learning. *Sharlok (Sharing, Linking and Looking-for Knowledge)* has been developed as a testbed of the KA (Ogata & Yano, 1996b). Sharlok is an open-ended and collaborative learning environment, and it integrates a knowledge building tool with a collaborative interface tool. Sharlok allows learners: (1) to share their respective knowledge in its shared knowledge space, and to explore this knowledge space freely, (2) to make hypertext links between relevant knowledge, and (3) to collaborate about shared knowledge in an ad hoc group at real time. Evaluation of Sharlok showed that KA encouraged collaboration by exciting learner's curiosity and that KA effectively induced collaboration (Ogata & Yano, 1998). However, the problem arises that it is very difficult for learner to

understand the relationships between other learners and knowledge because KA is provided by text messages.

Recently, a number of educational systems are based on WWW. Generally, educational facilities are provided within these systems and the most notable additional need reflected across all of these systems is for facilities to make the presence and action of other users available across WWW. A variety of systems are tackling this core problem in a number of different ways, e.g., WebVis (Pitkow & Bharat, 1994), WAVE (Kent & Neuss, 1994), CGV (Girardin, 1995) and Footprints (Alan & Maes, 1997). Moreover, Palfreyman and Rodden (1996) developed an open awareness protocol for WWW.

This paper proposes *Knowledge Awareness Map* (KA map) that visualizes KA information on WWW. The map helps learner to mediate and recognize collaborators in the shared knowledge space. On this map, the system identifies learning-companions who can help solving a problem. The characteristics of the map are:

- (1) Visualization of the hyperlinks and categorization of pages on the Web as educational materials,
- (2) Visualization of the relationships between pages and learners to induce collaboration,
- (3) Recommendations of appropriate collaborators on KA map to help find suitable partners.

We are developing an open-ended collaborative learning support system, which is called *SharlokII*. SharlokII is a prototype for KA map, and facilities to share individual knowledge and to learn through collaboration on WWW pages. In this paper, first, the outline of SharlokII is described.

Knowledge Awareness Map

What is knowledge awareness?

KA is defined as awareness of the use of knowledge. In a distance-learning environment, it is very difficult for the learner to be aware of the use of other learners' knowledge because the learner cannot understand their actions in the remote site beyond Internet. KA messages inform a learner about the other learners' real-time or past-time actions: look-at, change, and discuss, that have something to do with knowledge on which a learner was or is presently engaged. For example, KA messages are "someone is changing the same knowledge that you are looking at", "someone discussed the knowledge which you have inputted." These messages make the learner aware of someone:

- (1) who has the same problem or knowledge as the learner;
- (2) who has a different view about the problem or knowledge; and
- (3) who has potential to assist solving the problem.

Therefore, these messages that are independent of the domain, can enhance collaboration opportunities in a shared knowledge space, and make it possible to shift from solitary learning to collaborative learning in a distributed learning space.

KA messages are classified into two dimensions: time and knowledge separation. KA of type same time (ST) informs the learner that other learners are doing something at the same time that the learner is using the system. By using learners' past actions, KA of type different time (DT) provides the encounters beyond time. KA of type same knowledge (SK) is a message about other learners' activities to the same knowledge that the learner is looking at, discussing, or changing. This type is available for learners to find partners who have the same problem or knowledge. KA of type different knowledge (DK) enhances collaboration possibility with another learner (1) who has had something to do with the learner's interests; or (2) who has different expertise from the learner's interests.

For example, the message of type STSK, "Who is looking at the knowledge?" shows the existence of learners who are looking at the knowledge that the user is looking at. By this message, the user may start to discuss on the knowledge. Likewise, the message of type DTSK "Who changed the knowledge since I have last looked at?" facilitates to start discussion on the changing of the knowledge. Moreover, the message of type STDK "What knowledge are they discussing?" is useful to join into the discussion that interests the learner.

KA has a close relation with learner's curiosity. Hatano and Inagaki (1973) identified two types of curiosity; particular curiosity (PC) and extensive curiosity (EC). EC occurs when there is a desire for learning and it makes the learner's stock of knowledge well balanced by widening the learner's interests. PC is generated by the lack of sufficient knowledge, and it is very useful in that the learner can acquire detailed knowledge. KA of type SK excites PC, and KA of type DK satisfies EC. For example, a message of type STDK stirs up the

learner's EC by attracting the learner to the particular knowledge when the learner focuses on nothing. Moreover, the message of type STDK about the knowledge leads the learner to collaboration by arousing the learner's PC. In this way, KA induces collaboration by exciting the learner's curiosity.

Knowledge Awareness map

In our previous research, Sharlok presented KA information as a text message. From the text message, however, it is very difficult for learner to understand how the other learner is very interested in the knowledge. The other learner may be a vital helper who can assist the learner to understand the knowledge deeply, or may be just looking at the knowledge. Therefore, we propose *Knowledge Awareness Map* that graphically displays KA information. This map provides learner with a clear grasp of some learners around knowledge that is separated from a learner-looking knowledge. With this, the learner can seek for the learner of the discussion companion interactively.

As for the visualization of WWW space, an awareness support system (Palfreyman & Rodden, 1996) was developed in order to displays the links between WWW pages and the users who are accessing the pages into both 2D and 3D representation. This system displays the user who is only referring pages at real-time and the links of the pages. In addition to this, KA map shows the degree of learner's interests and recommends adequate collaborators.

Learner's profile

The system collects learner's profile with two techniques:

- (1) The action log of learner: e.g., access times to WWW page;
- (2) The explicitly registration by learner.

The actions of learner in an open-ended learning environment can be classified as follows: (A)creating a category, (B)creating knowledge, (C)making link to WWW pages, (D)asking a question, (E)answering the question, (F)modifying knowledge, (G)participate discussion, and (H)looking at knowledge. These eight actions of learner are used as one of learner's profile. However, it is difficult to detect the knowledge and the interest of the learner from learner's actions only. Therefore, it is necessary that the learner register his/her own interests on the knowledge. SharlokII realizes the registration of the interests of the learner with *footprints*. Footprint is an explicit flag that shows learner's interest to a shared knowledge.

Strategy for recommending peer learners

When learner asks a question and seeking for a helper, the system recommends one to three persons. The type of the learner who participates in collaboration is shown below:

- (1) Questioner: This learner has some questions and requires collaboration.
- (2) Answerer: This learner answers the question of the questioner.
- (3) Participant: This learner is interested in the question and wants to join into the collaboration.

The system recommends an answerer who can help problem-solving and some participants to a questioner. The system selects a learner using the following information:

- (1) The login situation of learners:
Because of real-time discussion, the system selects only logged-in users as candidates.
- (2) The footprints of each learner:
Participants are selected from those who put the footprint in the knowledge (page) of the question.
- (3) The profile of each learner:
Although the profile consists of the number of action times to the knowledge, the system has to evaluate totally. If the total of (A)-(D) actions of a learner is larger than that of (E)-(H) actions, then the system considers the learner as an answerer. Otherwise, the learner is a participant. The larger the total of a learner's actions, the more the learner is preferred to join into collaboration.
- (4) The current action of learner:
The system gives a high priority to learners who are doing nothing (idle) in the learning environment. This consideration activates passive learners by stimulating their intellectual curiosity.

This paper proposes the level of interest (LOI) as follows:

$$LOI = \left\{ F + \frac{\text{The number of the learner's actions to the page}}{\text{The max number of other learner's actions to the page}} \right\} \times \frac{1}{2}$$

Variable F shows the footprint given by learner. The value of F is 1 if learner takes a footprint to the page, otherwise 0. The range of LOI is from 0.00 to 1.00.

Visualization of KA

A link in KA map shows the relationship between web pages and learners. The length (L) of a link means the strength of the relationship and it is calculated by the following equation:

$$L = D(2 - LOI)$$

where, D is a default value of link length.

The range of L is from D to $2D$. If a learner is very interested in a page, the link length (L) of between the page and the learner becomes short and nearing to D .

Implementation of Knowledge Awareness Map

Collaborative learning environment

Interface of the collaborative learning environment of SharlokII is shown in Figure 1. The left side shows an interface of a questioner, and the right side shows an interface of an answerer or a participant. Screen (a) is a main window of SharlokII. The learner can access to knowledge (page) in the right frame on window (a). The left frame of the window (a) shows the SharlokII functions, e.g., create WWW page, keyword search and so on. Window (b) is displayed in opening a page. The discussion is requested by clicking the "collaboration" button. Then, window (c) is shown, where the system recommends suitable collaborators for the question, and learner can also arrange other learners who the learner wants to join into the discussion. The request status is displayed on the right frame of window (a).

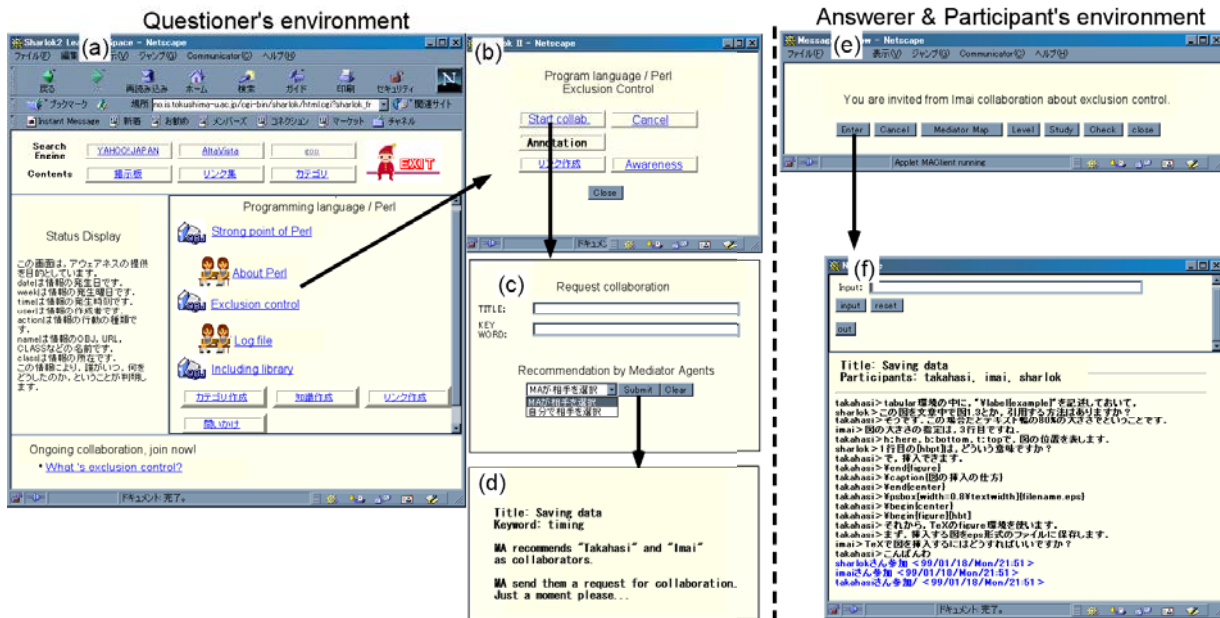


Figure 1. Collaborative learning environment in SharlokII.

Window (d) in figure 1 finally displays the candidates who the learner requests collaboration. Window (e), (f) are the screen of another learner to have required discussion. Window (e) displays an invitation message from the questioner. The message includes the questioner's names, the page title that has required to the discussion, and a knowledge name, and the title of the question. With the "OK" button on window (e), the learner accepts a

discussion request, and then the learner can participate in the discussion. In window (f) the learner can start collaboration. If the requested learner rejects the invitation, the questioner can know that in status window (a).

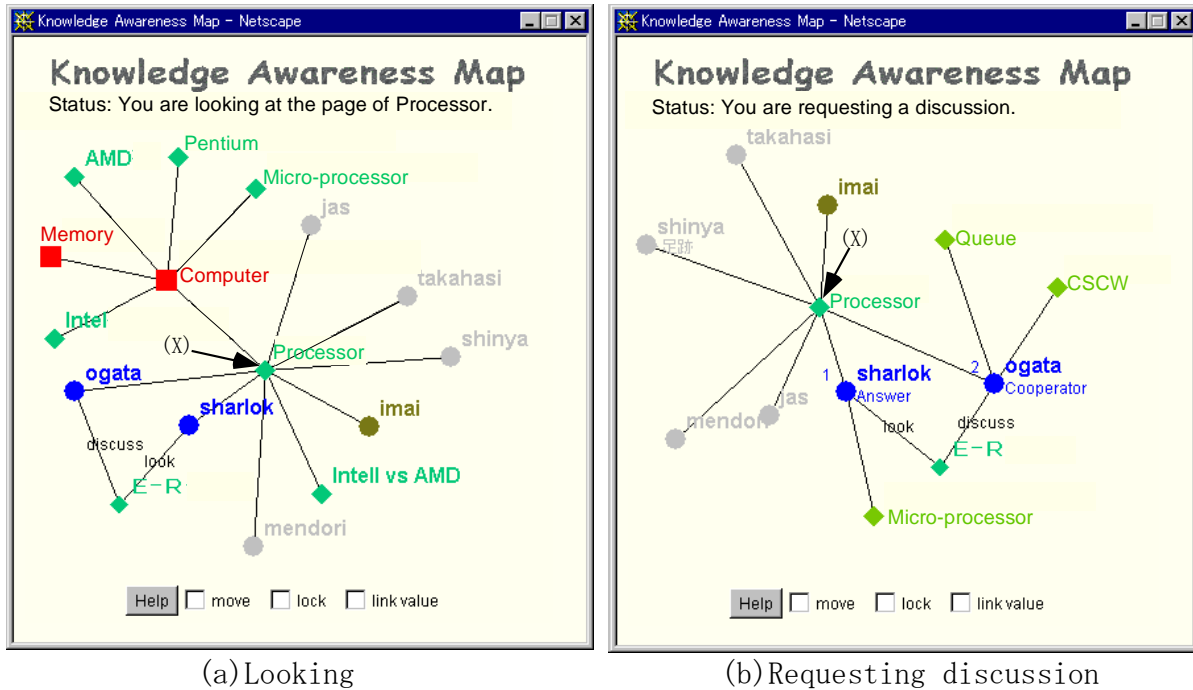


Figure 2. Knowledge awareness map.

KA Map

KA map is shown in figure 2. The map is displayed in opening SharlokII. When the user “imai” is looking at page (X), window (a) is appeared. The nodes of window (a) consist of categories of web pages, web pages that belong to the same category, and learners. Moreover, the system identifies learners on the map (b) into the user, a questioner, an answerer, a participant and the others when the user starts to request discussion. A close line means the learner is strongly interested in the page. When the user looks for learning companions about a topic, the user can find peer learners who have strong interests, using this map. When the user requests a question, the user can comprehend who is an appropriate answerer through this graphical map. Moreover, when the user receives the invitation of discussion from another learner, the user can understand the backgrounds of the inviting learner. By clicking a person node, both the personal information of the learner and his/her past actions about peripheral knowledge are displayed.

Conclusions

This paper proposed KA map that supports learner to find appropriate companions for his/her problem-solving in an open-ended collaborative learning environment. To evaluate KA map, SharlokII was developed on WWW. The result of the evaluation is as the following.

- (1) By the agency of the system, it is possible to discuss with the appropriate companion.
- (2) With the agency support, the learner can do to do lively discussion.
- (3) By the lively discussion, the contents of the discussion can be put to the learner in the impression.
- (4) In to use KA map helping, it is possible to correspond in case of the analysis failure of the system.

In the future, it considers the composition of learner profile and a way of making more, it improves the analysis precision of the system and it evaluates once again.

Acknowledgements

This work was partly supported by the Kayamori Foundation of Informational Science Advancement, and the Grant-in-Aid for Scientific Research No.11780125, No.12558011, and No.13780121 from the Ministry of Education, Science, Sports and Culture in Japan.

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