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AUTHOR	Ogata, Hiroaki; Yano, Yoneo
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ABSTRACT

This paper describes Coconuts (Concurrent Collaborative Learning Environment Supported by Awareness), a proposed module of Sharlok (Sharing, Linking and Looking-for Knowledge), an open-ended and collaborative learning environment that integrates a knowledge building tool with a collaborative interface tool. Coconuts was developed in order to support knowledge awareness (KA) during collaborative learning with Sharlok. Topics discussed include: collaborative learning in an open group, including an open-ended collaborative learning environment, the time dimension of open-ended collaborative learning, and the taxonomy of participation; an overview of Sharlok as a personal and collaborative learning environment; an overview of KA; and an overview of Coconuts, including features, system configuration, and the user interface. Results of an evaluation of Coconuts, in which nine master course students used Sharlok for 4 hours--2 hours unsupported by Coconuts and 2 hours supported by Coconuts--are presented. It is concluded that provision of awareness facilitates participation in multiple and concurrent collaboration and reduces wasteful formal participation, and that informal communication activates collaboration. A table categorizes collaborative learning in a closed versus open group, and five figures present a diagram of open-ended collaboration, the participation form of concurrent collaboration, the system configuration, screens of Coconuts in Sharlok, and frequency of participation results. Contains 12 references. (DLS)

Supporting Awareness for Augmenting Participation in Collaborative Learning

Hiroaki OGATA and Yoneo YANO
Faculty of Engineering, Tokushima University, Japan
E-mail: {ogata, yano}@is.tokushima-u.ac.jp
URL: http://www-yano.is.tokushima-u.ac.jp/

Abstract: Knowledge awareness (KA) has been proposed for increasing collaboration opportunities in an open ended and collaborative learning environment. KA consists of information about up-to-minute activities of other learners. For instance, it indicates when someone is looking at the same knowledge that learners are looking at. Multiple collaboration is concurrently realized through KA. This paper describes a concurrent collaborative learning environment supported by awareness, toward augmenting participation in collaborative learning. We tested and verified the effectiveness of this system in an experimental training.

I. Introduction

Recently, a number of collaborative learning environments have been built advocated by educational theories[[O'Malley 94], e.g., CoVis [Edelson et al. 96], KIE [Linn 96], and CSILE [Scardamalia & Bereiter 96]. CoVis focus on making a collaboration process visible. KIE succeeds by helping students link, connect, distinguish, compare, and analyze their repertoire of ideas. Moreover, CSILE supports knowledge building for the creation of knowledge. In such environments, the learners actively provide their own knowledge into the system.

Knowledge acquisition and open ended CAI systems [Yano et al. 92] have been proposed to enhance and sustain learners' motivation. Especially, when learners acquire knowledge in the context of an open-ended activities, they are more likely to use that knowledge later. Similarly, in collaborative learning, distributed expertise and multiple perspectives enable learners to accomplish tasks and develop understandings beyond what anyone could achieve alone. Lave and Wenger [Lave & Wenger 91] suggested that the consideration of learning as legitimate peripheral participation (LPP) in communities of practice can be a valuable analytical perspective. Therefore, it is very important for learners to collaborate with each other. However, little attention has been given to the technical support for inducing and augmenting participation in collaboration.

In computer supported cooperative work (CSCW), a collaboration process has been described as a four processes model [Matsushita & Okada 95] which includes the elements of co-presence, awareness, communication, and collaboration. Co-presence gives the feeling that the user is in a shared work space with someone at the same time. Awareness is a process where users recognize each other's activities on the premise of co-presence. In the next process, the user collaborates on the specific task with other users and accomplishes the task and common goals. To increase communication opportunities, awareness is one of the most interesting topics. For example, awareness informs what other users are doing, and where they are working. These information facilitates informal communication between distributed users.

We have suggested that knowledge awareness (KA) is an important factor in collaborative process because not only it assists learners who are interested in the same knowledge but also it creates effective collaboration in an open ended learning environment [Ogata et al. 96a, Ogata & Yano]. KA gives the learner the information about other learners' activities in a shared knowledge space. KA encourages collaboration by exciting learner's curiosity and it fosters active learning.

Sharlok (Sharing, Linking and Looking-for Knowledge) [Ogata et al. 96b] has been developed as a testbed of KA. Sharlok is an open-ended and collaborative learning environment. It integrates a knowledge building tool with a collaborative interface tool. The result of the evaluation of Sharlok was that KA was very effective for inducing collaboration. However, KA has not yet been supported in the middle of collaboration. In this paper, we describe how KA during collaborative learning can be supported by Coconuts (Concurrent Collaborative Learning Environment Supported by Awareness).

We firsts describe the nature of collaborative learning in an open group in section 2. Section 3 presents overview of Sharlok and KA. In section 4, we presents the features and implementation of KA during collaborative learning. Moreover, we describe the experimental results of this system in section 5. Finally, the concluding remarks are given in section 6.

I. Collaborative Learning in an Open Group

A. An open-ended collaborative learning environment

Our research focuses on open-ended collaborative learning using computers and Internet. Table 1 shows several variables of collaborative learning in a closed group and in an open group. In a closed learning environment, like for instance, an ordinary classroom, a teacher organizes groups, gives the subject to the each group, and sets the time table for the discussion in advance. In this case, the learners can easily be very passive in group participation. Compared with this, learning in open groups is very active and learner-centered. The learner can join into discussions spontaneously and the participants of each discussion may be changing during time. Since, the students set the topic of the discussion based on their curiosity, so the beginning of the discussion is not previously defined. Moreover, in the open group, the participant can communicate both with other participants and with non-participants as well. It is very important for the participants to interact with non-participants for gathering information and understanding the topic of the discussion more deeply.

Table 1: Collaborative learning in a closed vs. open group.

Discussion	*Closed*	*Open*
Participants	Arranged	Random
Topic	Preset	Ad hoc
Time	Scheduled	Unscheduled
Communication	Inside group	Inside & outside group

A. Time dimension of open-ended collaborative learning

Figure 1 shows a time chart of open-ended collaboration. There are three parallel sessions in this situation. Learners can be classified into those who:

(1) participate since the beginning of the session;
(2) participate halfway through the session;
(3) leave halfway through the session; and
(4) leave at the end of the session.

From the chart, we can conclude between others, the following facts. Although the participants of discussion C did not change, participants changed during discussion A and B. The learner X did not understand which session to join neither how to participate in the discussion. Therefore, we propose that the system should support the learner to understand the discussions.

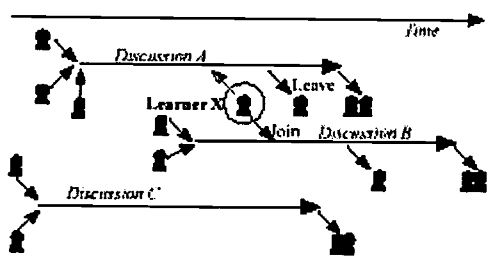


Figure 1: Diagram of open-ended collaboration.

A. Taxonomy of participation

In open-ended collaboration, there can be found some different kinds of participants except non-participants (see fig. 2):

(1) *Observational participant (OP)*: In this case, the learner only observes a discussion without utterances. Through observation, the OP can understand multiple discussions and eventually decide to join one of them.
(2) *Direct participant (DP)*: In this situation, the learner joins in a discussion and his/her opinions are shared and can be discussed by all of the DP of the same discussion team.
(3) *Indirect participant (IP)*: In this case, an OP interacts with DPs of any discussion team but without going any particular team. This situation can be motivated in two different ways, either a non-participant (NP) decides by himself/herself to give advice to a DP, or any DP asks a NP to give his/her opinions. The advises from the NP often makes the discussion active. Therefore, indirect participation is very significant to argument participation in collaboration. In this context, the communication may be informal because not all of the DP may know about the communication in which the NP is involved. An OP is a better collaborator than a NP because the OP knows the content of a discussion. Awareness of collaboration is needed to allow users such informal communication.

The learner may concurrently participate in multiple collaboration by combining different kinds of participation. To augmenting participation in collaboration, educational groupware systems should support observational, direct and indirect participation.

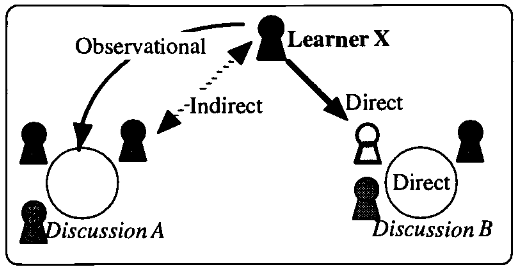


Figure 2: Participation form of concurrent collaboration.

I. Overview of Sharlok and Knowledge Awareness

A. Sharlok

Sharlok has an open ended and collaborative learning environment connected via Internet. The characteristics of Sharlok are the following:

(1) Sharlok allows learners to share their respective knowledge, consequently the learners can cover the lack of mutual knowledge each other.
(2) Learners can explore in a shared knowledge space according to their interests.
(3) Learners can link between relevant knowledge by hypertext link. Using such a shared knowledge space, they can learn covering multi-domain.
(4) By creating or joining collaboration during its use, learners can confirm or correct the knowledge. This process supports practical learning.

1. Personal learning environment

The personal learning environment of Sharlok has the following functions:
(1) the definition of a class;
(2) the creation of an instance object of a class;
(3) browsing search for objects;
(4) authoring of links between heterogeneous objects; and
(5) navigation of objects.

Sharlok enables learners to create and define new classes. Learners can create objects and input their knowledge by using pairs of attributes and values, texts and figures. They can start collaboration by asking a question. Sharlok invites learners to do collaboration. If the learner agrees, he/she becomes a participant of the collaboration.

1. Collaborative learning environment

Sharlok allows learners to communicate and collaborate in a collaboration window which consists of a text chat tool, and a group drawing tool. In the text tool, participants can write their respective ideas. Moreover, the drawing tool shows their mouse pointers and it allows them to draw figures at real time. Sharlok records the processes of the collaboration and it makes this information retrievable and accessible for all the learners.

A. Knowledge awareness

In CSCL, awareness is very important for effective collaborative learning and it plays a part in how the learning environment creates collaboration opportunities naturally and efficiently. Awareness may lead with informal interactions, spontaneous connections, and the development of shared knowledge. Although a large number of studies have been made on such awareness in single group collaborative learning, little is known about awareness for multiple and concurrent collaborative learning.

We assume that KA is the information for enhancing collaboration opportunities in a shared knowledge space (see [Ogata et al. 96a]). Its messages are about the other learners' real-time or past-time actions, that have something to do with knowledge on which a learner is doing or had already done. KA makes a learner be aware of someone who: (1) has the same problem or knowledge as the learner, (2) has the different view about the problem or knowledge, and (3) has potential to assist him/her in the problem solution.

There are two ways for providing KA: "passive awareness" and "active awareness". In the passive way, the system does not show awareness information until the learner requests it. In contrast, active awareness is autonomously informed to the learner. Sharlok induces spontaneous collaboration between learners using active awareness. For instance, User A may start to collaborate with User B by active KA which informs that User B has updated User A's knowledge. However, it is necessary to inform a learner only the important part of KA instead of all of KA. Therefore, we have proposed a new method for filtering KA [Ogata & Yano 97].

KA has a close relation with learner's curiosity. Hatano & Inagaki [Hatano & Inagaki 73] identified two types of curiosity; convergent curiosity (CC) and divergent curiosity (DC). DC occurs because the desire of learning which makes learner's stock of knowledge well-balanced by widening learner's interests. On the other hand, CC is generated for the lack of sufficient knowledge, it is very useful so that the leaner can acquire more detailed knowledge. KA induces collaboration by exciting learner's curiosity. In this way, KA assists creating real-time collaboration. However, awareness for concurrent collaboration is not proposed.

I. Coconuts

A. Overview

We propose Coconuts (Concurrent Collaborative Learning Environment Supported by Awareness) module in Sharlok in order to facilitate the participation into an open-ended collaborative group. Coconuts informs up-to-minute the participants' activities of concurrent collaboration. To augment the participation in collaboration, Coconuts has the following features:

(1) Awareness support for observational participants: In order that learners can be aware about what is discussed and who is participanting, Coconuts allows them to peep at multiple collaboration. After awareness of collaboration, the user can see the multiple discussion at the same time. Because direct participants do not know the existence of observational participants, the collaboration is not disturbed.
(2) Awareness support for indirect participants: Coconuts allows the user to communicate informally in the following ways: (a) from non-participants to participants; and (b) from participants to non-participants.
(3) Awareness support for direct participants: Coconuts allows learners to communicate and collaborate in real time. This environment provides workspace awareness for participants. Moreover, the system informs the participants who can help the discussion. Therefore, the participation of discussion increases;
(4) Awareness support for non-participants: Coconuts lets non-participants know which discussion to join into. Particular, the system actively shows the users the information about discussion only when users are not doing any operation.

A. System configuration

Sharlok consists of a client and a server program (see fig. 3). The server has four components: a shared database, a history database of learners' actions, an awareness server and a collaborative tools server. The shared database stores students ideas and collaboration processes. Awareness server manages the history database. On the other hand, a client has a student monitoring module, an awareness client, a collaboration tools client and a user interface module. Sharlok monitors the learners' activities in the shared knowledge space and it stores them into the history database. Awareness client provides awareness to the learner according to learner's actions.

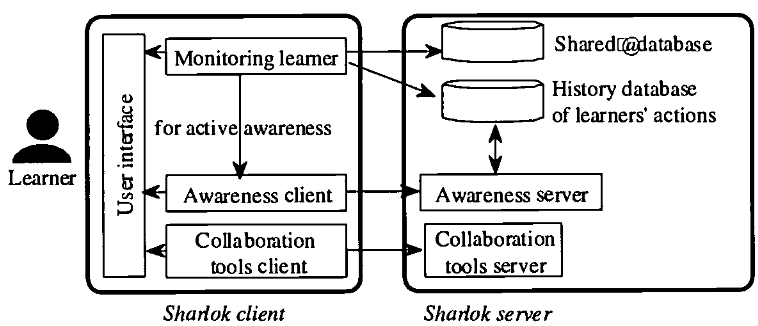
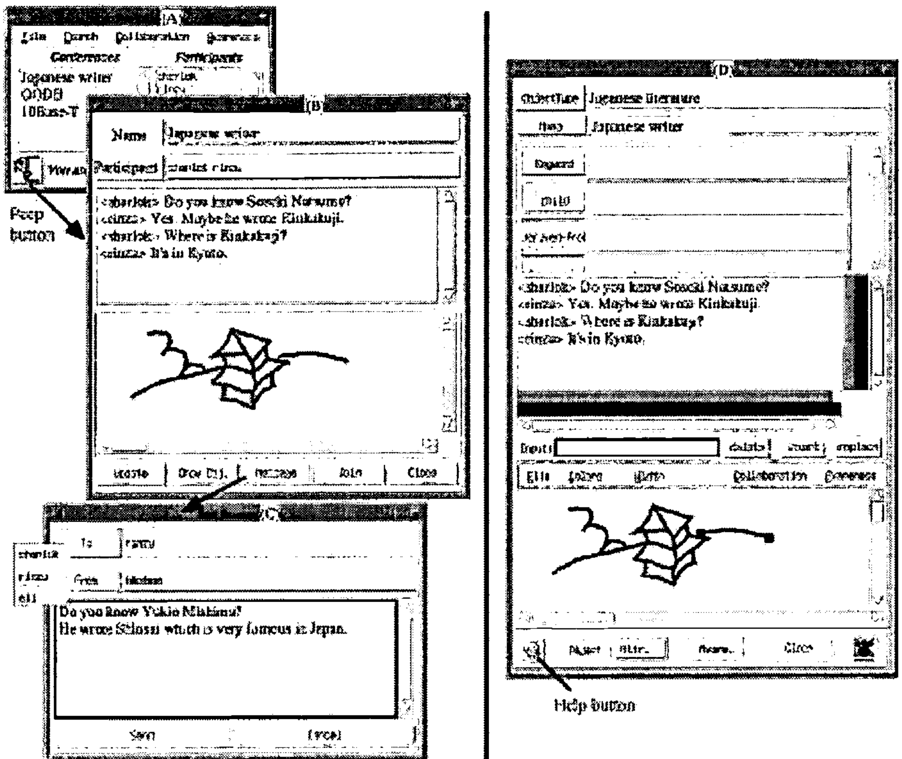


Figure 3: System configuration.

A. User interface

We have developed Coconuts using Sharlok. Figure 4 shows some screen snapshots of Coconuts in Sharlok which is used by two users: "sharlok" and "rinzu". "rinzu" collaborates about Japanese writers with "sharlok." Window (A) denotes the titles of current discussions and their respective participants. If the user selects a topic and pushes the peep button, coconuts shows the up-to-minute snapshot of the discussion as shown in window (B). The update button allows users to see the current collaboration state. The user can take part in the discussion with the join button. Coconuts allows users to observe multiple collaborative groups. The user can send a message by pushing the message button. In window (C), "takahasi" informally communicates with "rinzu". Moreover, a formal participant "rinzu" can ask some question about the discussion by selecting the help button. "To list" shows who can receive the message from the user. Coconuts provides the user with a message window like this shown on window (C) and "To list" shows who to send the user's message.



Screen of an observational participant (takahasi) Screen of a formal participant (rinzu)

Figure 4: Screen of Coconuts in Sharlok.

I. Experimental Results

To evaluate Coconuts, we integrated a group of nine master course students. They had been using Sharlok during over 4 hours; two hours unsupported by Coconuts (group A), and another two hours supported by Coconuts (group B). Each user explored into the shared database and discussed sixty times about different topics, for example, SGML, OODB and 10Base-T.

Figure 5 shows the experimental result. The total frequency of participation of group B was higher than that of group A because Coconuts provides awareness and different kinds of participation. In particular, IP was very effective for increasing participation. In group B, the provision of awareness decreased wasteful formal participation. Some users mentioned that Coconuts helps to reduce the number of participants who left the discussion before it finishes. By OP, the users could understand the contents of multiple collaboration. The learners learned actively through real-time collaboration, and they felt satisfaction and attainment of learning after the test.

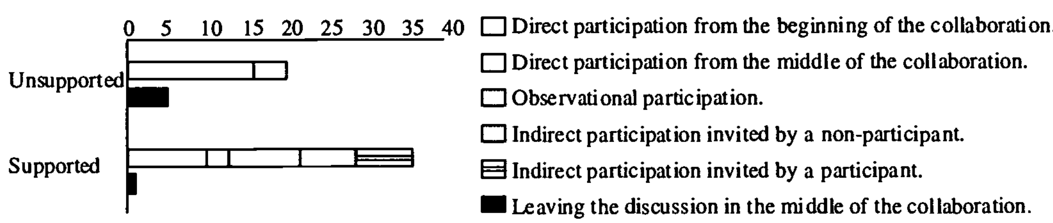


Figure 5: Frequency of participation.

I. Conclusions

In this paper, we proposed Coconuts for supporting awareness in a concurrent collaborative learning environment. We reached the following conclusion based on the experimental result of Coconuts:

(1) The provision of awareness facilitates the participation in multiple and concurrent collaboration and it reduces wasteful formal participation.
(2) Informal communication activates collaboration.

Although this paper describes a short term experiment, we will continue using and evaluating Coconuts in the future.

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